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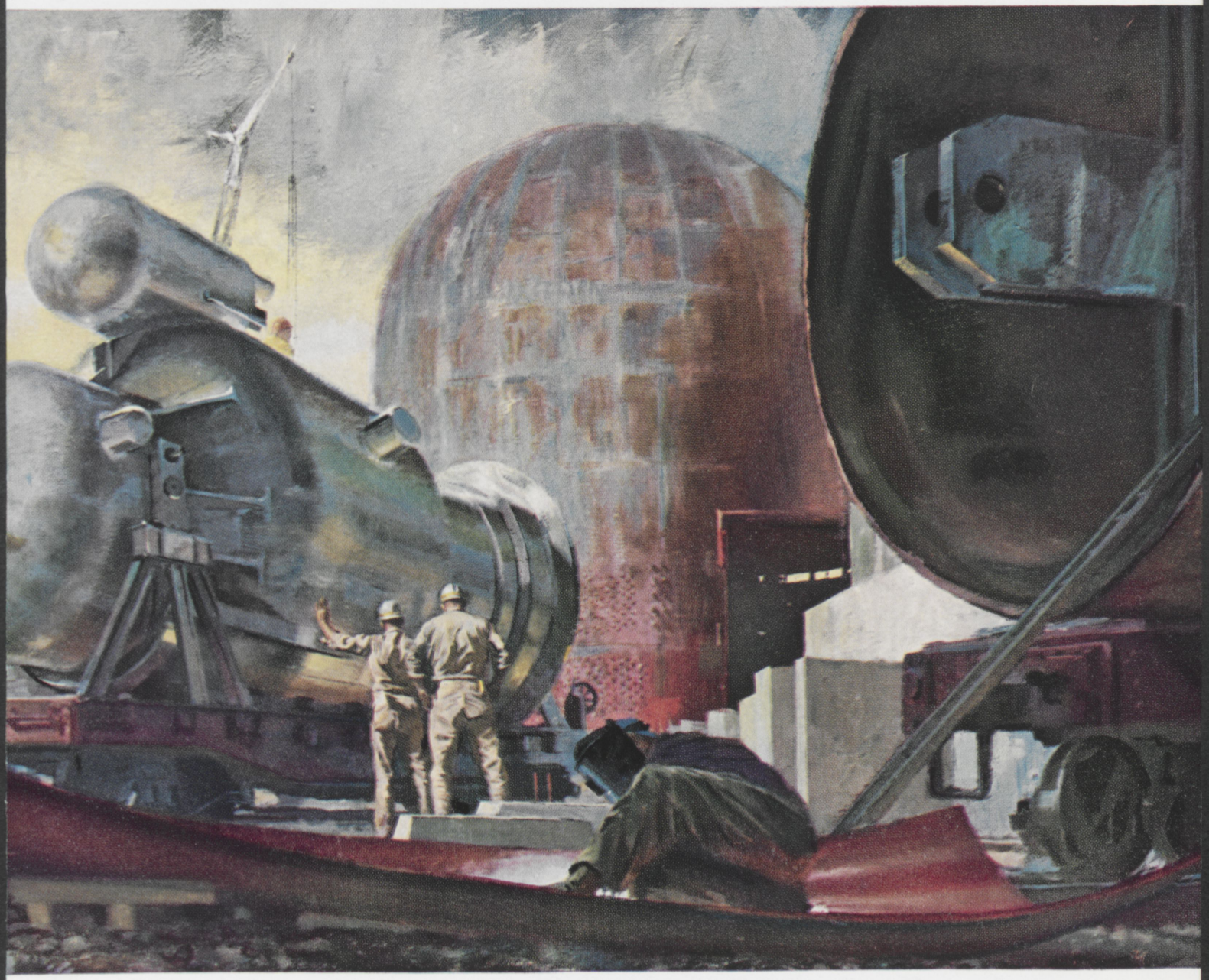
Rose Technic Staff
Rose-Hulman Institute of Technology

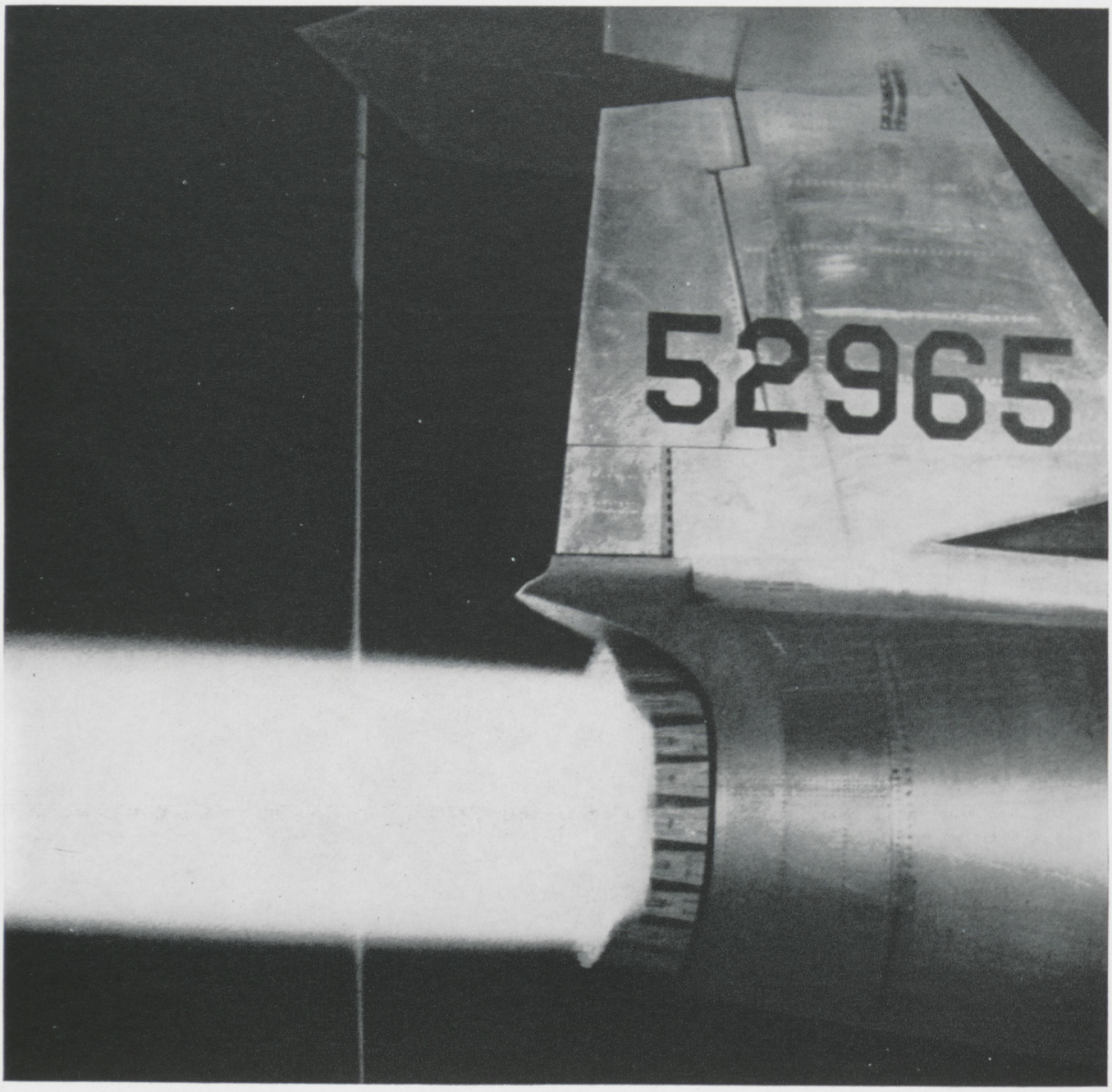
Rose Technic

March, 1960

Painting by Stanley Meltzoff



In This Issue



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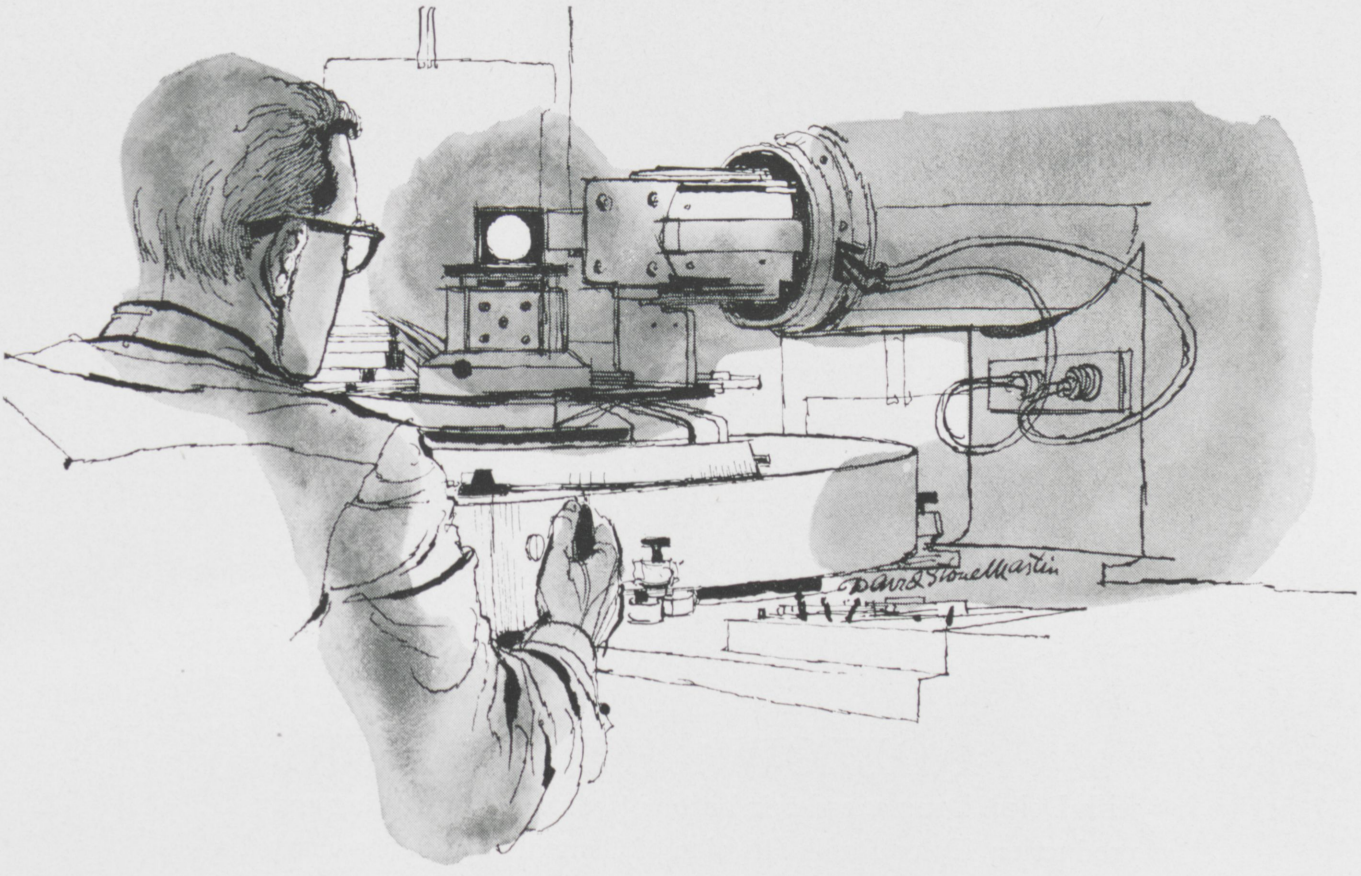

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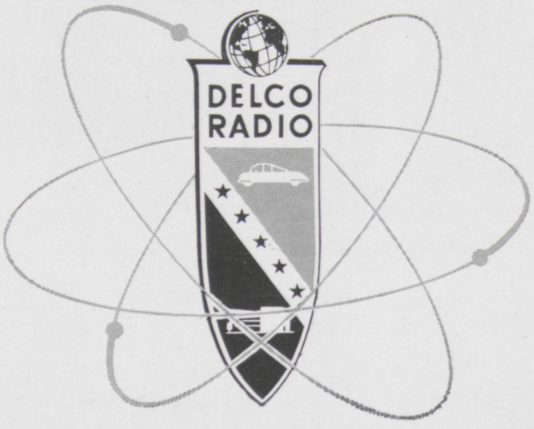

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KOKOMO, INDIANA

Rose Technic

VOLUME LXXI, NO. 6 MARCH, 1960

Contents

Cover Note

A reactor reports for duty. Reproduced through the courtesy of United Engineers & Constructors Inc. of Philadelphia, Chicago and New York.

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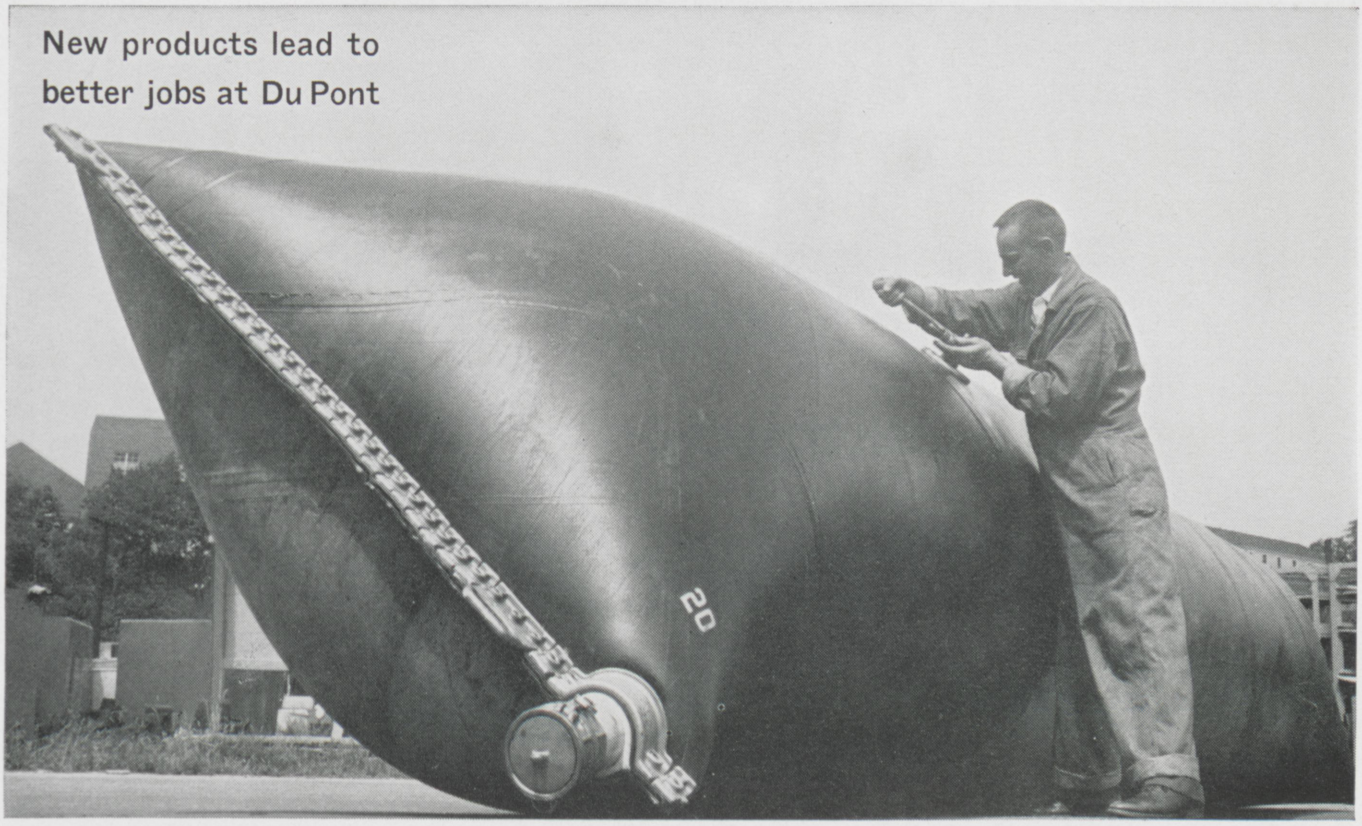

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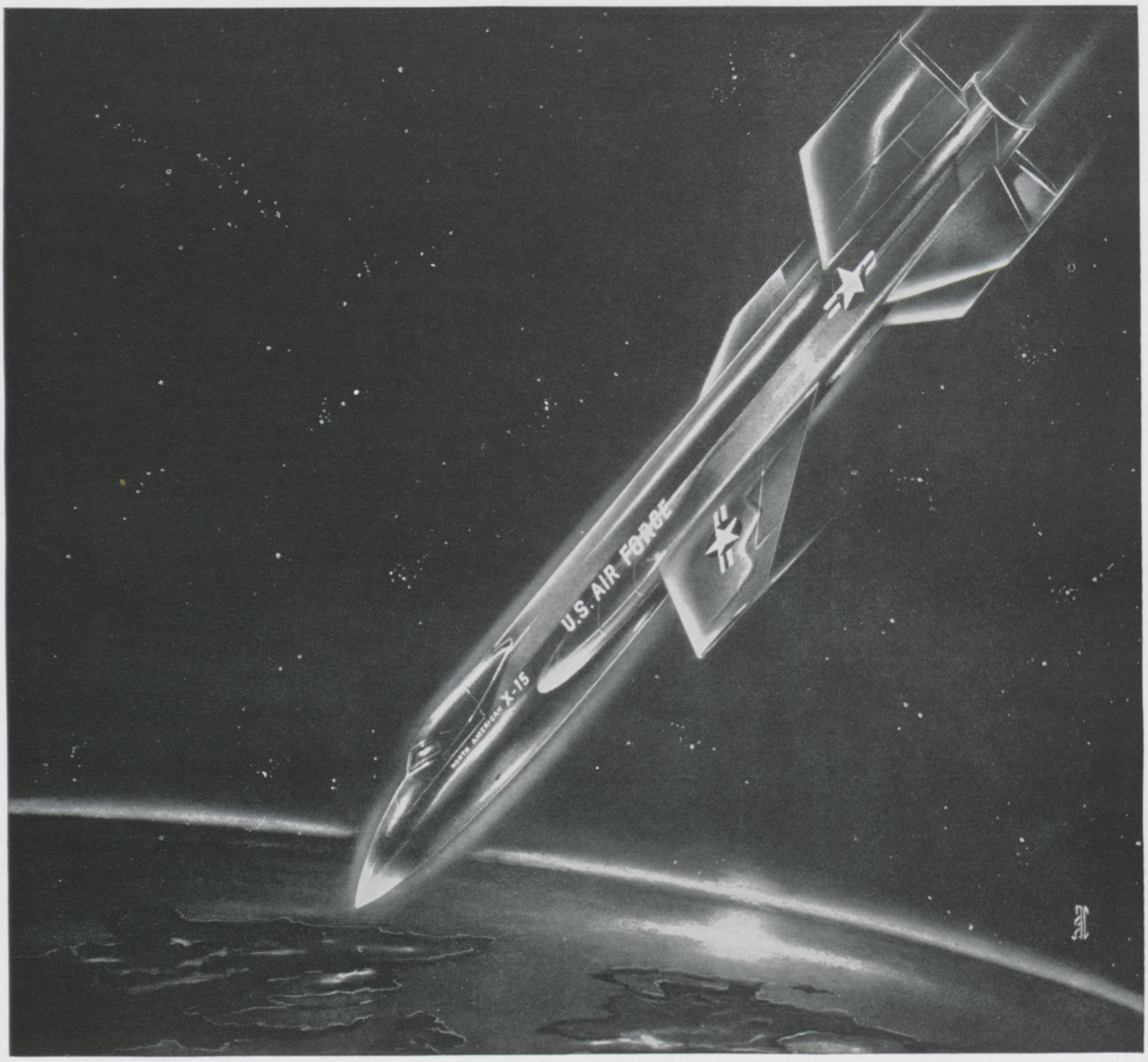

Nosing its way down to earth, X-15's skin of a high-Nickel-containing alloy will glow with the dull cherry red of a tossed rivet.

Inco-developed alloy to help X-15 carry first man into space

Alloy perfected by Inco's continuing research program will help new rocket plane withstand destructive heats

When the first manned rocket plane streaks in from space, temperatures may build up to as high as twelve hundred degrees.

The ship's nose and leading edges heat to a dull glowing red in seconds. At this destructive temperature, X-15's metal skin could weaken, could peel off.

Aircraft research personnel found the answer to this high-temperature problem in one of a family of heat-treatable nickel-chromium alloys developed by Inco Research. It withstands even higher temperatures than 1200°F!

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Over the years, Inco Research has successfully solved a good many metal problems, and has compiled a wealth of information to help you. You may be designing a machine that requires a metal that resists corrosion, or wear, or high temperatures. Or one that meets some destructive combination of conditions. Inco Research can help supply the answer. Help supply the right metal, or the right technical data from its files.

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F. Kelly, W. J. Miller, and J. P. Tobin of the Westinghouse Atomic Power Department lift the "core plate" off the nuclear core for the first U.S.-built power reactor designed for use abroad (Mol, Belgium).

Waltz Mill Experimental Reactor helps Westinghouse engineers solve problems

The new Westinghouse Testing Reactor at Waltz Mill, Pa., provides engineers with complete facilities for analyzing the effect of nuclear radiation on various materials, processes and designs. If a Westinghouse engineer is working on development of atomic fuels or the design of reactor components for an atomic power plant, he can count on help from the men at Waltz Mill.

The Westinghouse Testing Reactor is one of only two such privately owned reactors in the country. It provides a high radiation field comparable to that of a working reactor, and in addition has special controlled environment loops for the study of radiation effects at high temperatures and pressures. Work presently being carried out here for other departments of the company includes studies of thermionics, crystal structure, and thermoelectric effects as well as the work on atomic reactor designs and fuels.

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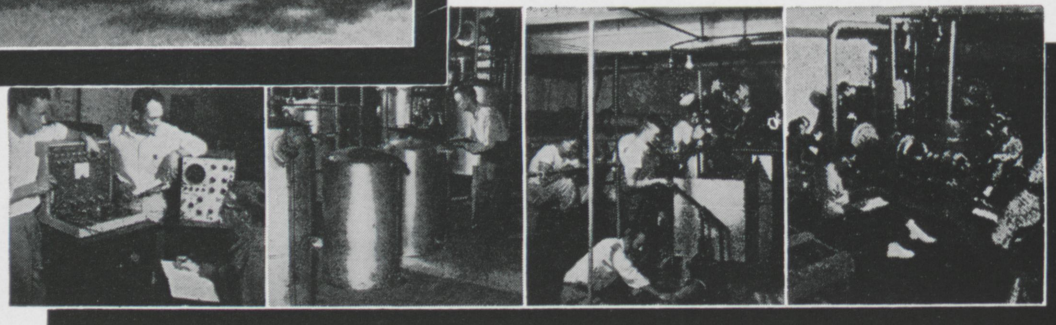

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Simply dedicating ourselves to the support of our families is ruled out for us, as bachelors of science. As engineers and scientists, we'll be among the last to starve, regardless of the work in which we are engaged. The goals from which we must choose are far more elusive.

Goals which we purport to discard, but sometimes don't, are wealth, power, and recognition.

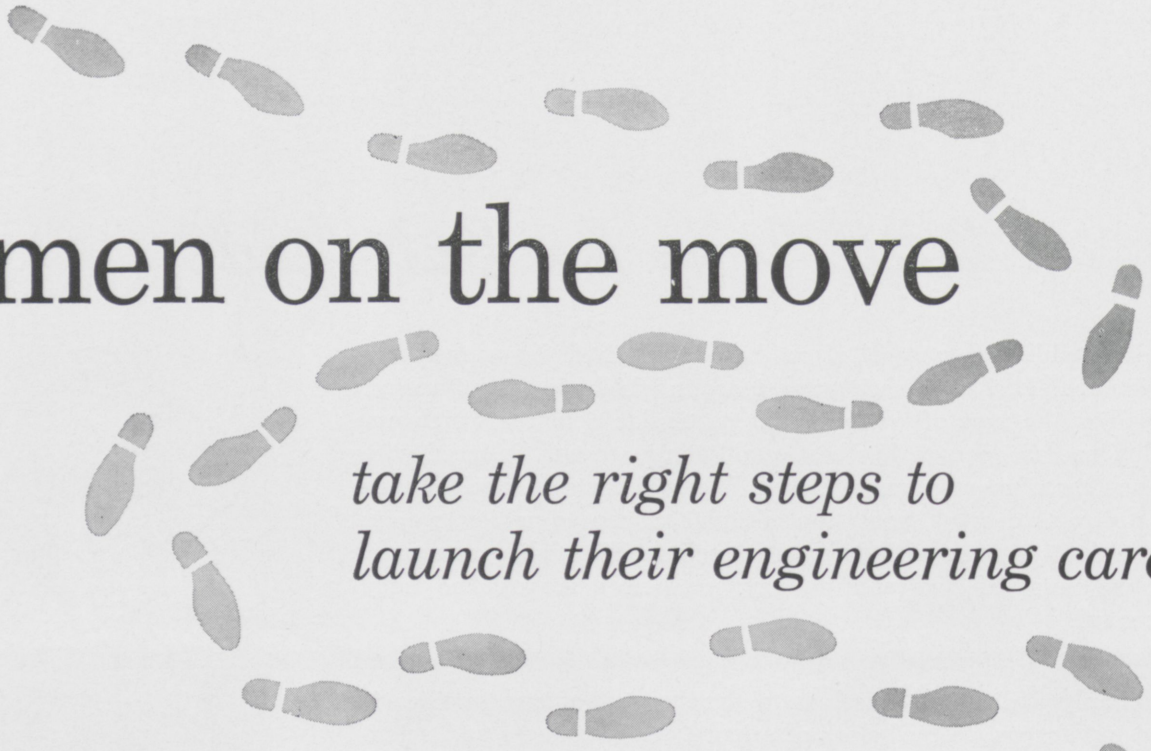
Immediately after we get our sheepskin, we will begin asking ourselves what the answers are to problems. Sooner or later, we will begin asking ourselves why our organization wants the answers to the problems. We will wonder if the answers we work so hard to obtain are doing anybody any good.

Does the U. S. benefit when teams of engineers and tons of money are spent in developing a vertical broiler for a stove, simply because consumer demand for stoves with efficient horizontal broilers has dropped? Do gadgets—tailfins and vertical broilers—advance the frontiers of human knowledge? Will interplanetary travel make people happier?

Shall I devote my life to uncovering the mysteries of the universe? Why? To teaching others the basic physical relationships of the universe? Whatever for? To designing airframes for space vehicles? What good will that do? To utilizing the talents of others in the most effective manner? To selling a product or an idea in which I believe?

Am I going to be most satisfied with my job on payday?

J.W.F.



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From the

PRESIDENT'S DESK

Recently the United States Office of Education released the figures on engineering enrollments in the United States for September 1959. These figures showed that the entering freshmen in 1959 numbered 4% less than those who started in September 1958. In September 1958, the number of entering freshmen was 11% less than those who started a career of engineering as freshmen in September 1957.

This decrease in engineering freshmen occurred in the face of the greatest propaganda program stressing the need for more scientists and engineers that has ever occurred in the United States. I refer to the furor that was raised following the first Russian satellite which went into orbit in October 1957.

At first it was thought that the decrease in engineering enrollments was being counterbalanced by an increase in enrollments in courses leading to degrees in the basic sciences such as chemistry, physics, mathematics and biology. That there has been an increase in these areas is apparent but it is not sufficient to account for the rather sizable decrease in those who indicated a preference for engineering.

The next rationalization to explain the decrease was that the poor students and the ill-prepared students are not enrolling in engineering. Therefore, the drop-outs from failures and other courses would decrease and more than make up for the loss in enrollments. Unfortunately this hypothesis has not been borne out by the fact. The drop-out rate in the class which entered in September 1958 (the present sophomore class) has been greater nationally (and at Rose) than has been the case for other recent years. In addition, the drop-out rate of those who entered in 1957 (the present junior class) has likewise been inordinately great.

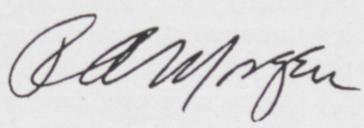
If this trend should continue for several years, the effect on the future of the United States could be quite serious. The rationalizers are now saying that a good many people are shunning an undergraduate curriculum in engineering because it is so much harder to earn a bachelor's degree in engineering than it is in other areas. If this is the case, the results for the United States would be most unfortunate. There is no more rewarding career than one of the many facets of engineering. Engineering is probably the most broadly based of any of the professional courses in which a student may enroll. Careers are open for engineers all the way from creative writers and lawyers on one end, to production and technical sales careers in the center and to fundamental research and teaching of engineering at the other end. In no other undergraduate professional curriculum is the number of opportunities for professional growth so wide and so rewarding.

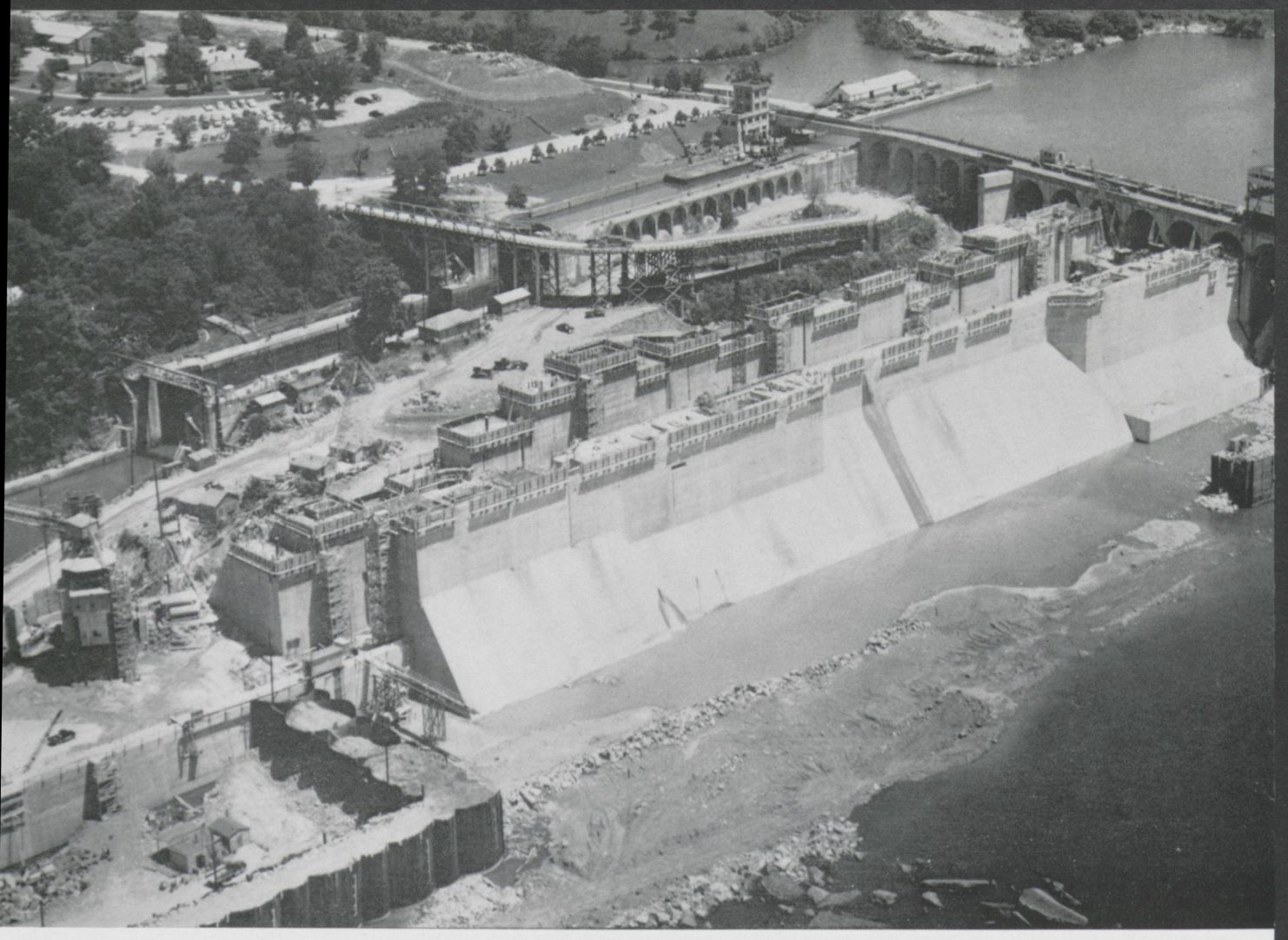
What then can Rose do to improve this situation? There appear to be two courses open in both of which we should be able to make some progress.

One of these courses is to demonstrate to the students the wide areas of opportunity for those people who have a board background in engineering and the sciences. With this kind of undergraduate education, the number of careers open to the graduates is greater than almost any other curriculum that they could follow. Those students who show apptitudes in certain directions and who are in the top portion of their classes will be permitted to deviate from the standard curriculum. This deviation might take such forms as specialized problems or honors courses for those persons who are interested in a career in research or a creative writing assignment for those who might be interested in technical writing.

The other course involves help to those students who are in the lower part of the class for various reasons. These students would be given specialized attention and, if necessary, a lighter scholastic load so that they could do well in those subjects which they took. This procedure might make it necessary for these students to take longer than four years to complete the standard curriculum but would save them from dropping out of college and thus being lost to the profession of engineering.

Therefore, Rose is attacking the engineering manpower shortage on two fronts. Those students in the upper portion of the class will be stimulated to greater achievement through the technique of special problems and an introduction to research. The students who are in the lower portion of the class either because they are slow starters or have had poor preparation will be assisted to graduate through the device of lighter loads for longer periods of time. If through these devices Rose can graduate a larger percentage of its students then the way will have been shown to other colleges and universities to do likewise. It is conceivable that the end result nationally could be an increase in engineering graduates despite the drop in freshmen enrollment.





FLY ASH: Part II

By Bill Perkins, sr., e.e.

TESTING OF FLY ASH

Many results of fly ash testing were summarized in the February issue of the ROSE TECHNIC. However, some of the most important tests have been run by two government organizations: the Bureau of Public Roads and the Corps of Engineers. The results of these tests will help round out the picture on fly ash testing.

The results of tests run by the Physical Research Branch, Bureau of Public Roads, show generally the strength developed in portland cement-fly ash mortars is lowered by increasing carbon content of the fly ash, raised by increasing the fineness as measured by the amount passing the No. 325 sieve, and lowered by increasing the water required for mortars containing fly ash. No relationship was found between the inorganic constituents of fly ash and the development of strength of the mortar. Tests show that fly ash may be used to inhibit the expansion resulting from the alkali-aggregate reaction. The amount of fly ash required to reduce this expansion below a safe limit varies with different fly ashes.

In general, tests indicated that at ages up to 28 days both flexural and compressive strengths were lower than comparable concrete without fly ash. After one year the specimens of concrete containing fly ash were as strong as or stronger than the plain concrete. Fly ash did not improve the resistance to freezing and thawing of concrete without entrained air. The Portland cement used was also found to be a strength factor. The concrete with fly ash generally showed less shrinkage than that without it. The resistance to calcium chloride damage was less with all fly ash substitutions than for plain concrete.

From 1950 through the present the Corps of Engineers, United States Army, has carried on a lengthy study of partial cement replacement in concrete at its Concrete Division, Waterways Experiment Station, Jackson, Mississippi.

The World's highest single lift, 100 ft., was built by the T.V.A. at the Wilson Dam in North Alabama. Totol project cost is estimated at $35 million. The old locks will be retained for emergency use.

Fly ash has been one of the major replacement materials used in this test. The results have been good, particularly in the use of fly ash in mass concrete.

A rating system was worked out to evaluate the usefulness of the different replacements. For structural concrete, with a water to cement ratio of 0.5, Type 11 cement, the rating at no replacement was 100. In comparison, with 30% fly ash by volume added the rating was still 100; with 45% fly ash by volume added the rating was only 45; with 60% fly ash the rating was 35. Ratings for Types I and IV cements were similar. No replacement was done with Type III cement.

For mass concrete, with a water to cement ratio of 0.8, Type II cement, the rating with no replacement was 55. In comparison, with 30% fly ash, the rating was 36; with 45% it was 30; with 60% it was 15.

With 45% replacement by fly ash the relative flexural strength of concrete with fly ash to concrete without replacement was 48% at 7 days and 78% at 28 days or 0.5 water to cement ratio and 64% at 28 days and 88% at 90 days for 0.8 water to cement ratio. The 90 day compressive strength of concrete with 45% fly ash relative to concrete without replacement was 74% for a modified cube and 78% for a 3-inch by 6-inch cylinder.

All in all, the results indicate that particularly for a mass structure where loads are not immediately applied, fly ash is a worthwhile replacement for some of the cement. Some poorer qualities may be acquired by this replacement, but the economics will more than make up for them.

Tests conducted by every agency or group lead to the same conclusion: even though some characteristics may be weakened, the economics of using fly ash in concrete will make it worthwhile in many different cases.

EXAMPLES OF STRUCTURES USING FLY ASH IN CONCRETE

Steam Power Stations in New York and New Jersey. Fly ash concrete was used extensively for heavy foundation work for large steam turbogenerators and for walls of water intakes. Some walls were five years old in 1956 and at that time showed no sign of deterioration. The concrete contained approximately 16% replacement of cement by fly ash.

Liberty Dam, Baltimore. Fly ash concrete was used throughout this dam, which was built to augment the Baltimore water supply. The dam is 704 feet long, 160 feet high above ground level, and 134.5 feet wide at its base.

Palisades Dam, Idaho. This is a large earth-fill dam built by the Bureau of Reclamation with fly ash concrete in the tunnel linings, intake structure, spillway, other discharge arrangements, and power station foundation and structure.

Hungry Horse Dam, Montana. The Hungry Horse Dam, built by the Bureau of Reclamation, is probably the best known structure in which fly ash was used. The basic mix for the interior of this 3,100,000 cubic yard dam contains 32% fly ash, or 2 sacks of cement and 90 pounds of fly ash per cubic yard. This structure is 564 feet high, 2115 feet long, and 355.5 feet wide at its base.

Canyon Ferry Dam, Montana. This structure is 1000 feet long, 225 feet high. Fly ash concrete with a slightly leaner mix than at Hungry Horse Dam was used throughout.

Johnson Steam Plant and Wilson Dam Lock, Tennessee Valley. The use of fly ash is widening even quicker than the American Society of Testing Materials can change its requirements to meet new situations. This incident occurred when the TVA used fly ash which did not meet ASTM specifications for specific surface fineness in the concrete for Units 7 to 10 at its Johnsonville Steam Plant and in the 450,000-cu. yd. Wilson Dam Lock. This fly ash, which was recovered by mechanical collectors in TVA steam plants, was thoroughly tested and found to be useful as the product from electrostatic precipitators, if properly used.

The current ASTM fineness requirement is 2800 square centimeters per gram which can be collected by electronic precipitators of the sort used in many coal-burning steam-electric stations in congested areas. TVA ash, collected mechanically, has a specific surface of about 2000 square centimeters per gram. At Johnsonville 20% of cement and 10% of sand were replaced by fly ash; the big advantages here were economics and workability. Similar mixes were used at Wilson Lock. Here other advantages were also noted:

1. The ultimate strength of concrete was increased over portland cement concretes.
2. The lime leaching was greatly reduced.
3. Fly ash concrete was much more watertight.
4. The drying shinkage was decreased.

The fact that not only cement but also sand was replaced requires explanation. Since the coarser fly ash makes the workability less than it would be if made with an equal quantity of portland cement (or portland cement partially replaced by fine fly ash), it is necessary to add fly ash in excess of the amount of cement replaced in order to get good workability and adequate strength. The excess volume resulting from this addition is compensated for by removing some of the sand from the mix. Thus the coarser particles of the fly ash might be regarded as a substitute for fine sand.

Bridges in Alabama. Like the Tennessee Valley Authority, the State of Alabama has used mechanically collected fly ash in its 2.5 mile Dauphin Island Bridge and in the Herron Bay and Fowl River Bridges near Mobile. The typical mix contained 5 bags of cement,

(*Continued on page* 32)

Emphasize Engineering

By Gary Phipps, sr., e.e.

Editor's Note: The following article was condensed by Gary W. Phipps, senior e.e., from a speech entitled "A New Order of Technological Challenege." The author of the speech is T. Keith Glennan, President-on-Leave from the Case Institute of Technology and Administrator of the National Aeronautics and Space Administration.

In the past few years, mankind has made a "quantum" advance in science and technology—an amazing explosion of minds and energies which have begun a new era. The early accomplishments in the Space Age have unlocked human imagination and spirit which point to an unparalleled thrust forward, and outward, from our earthbound habitat. The future is rushing down upon us—dismaying and chillingly alien, or inspiring and promising, depending upon how we approach it.

We are threatened already with massive and still-growing faults in understanding. "In science, particularly, the tendency more and more has been to penetrate farther and farther into chosen subjects until specialists dig themselves out of sight, out of hearing, out of understanding of what other scientists are doing in their own and neighboring fields. Even more alarming is the growing cleavage between science and scientists as a whole and the great mass of humanity in other callings."

"Perhaps we need a new breed of specialists—relaters—men who will seek out effective methods of interrelating the knowledge and the work of the physical scientist, the engineer, the politcal scientist, the humanist, and other professional disciplines." The need is urgent for scientists and engineers to combine their special interests into a more closely coordinated team if we are to meet the challenges that now confront science and technology. The day when the pure scientist and the applied scientist or engineer were scarcely on speaking terms should be beginning to be a thing of the past.

Today, the role of the engineer is growing constantly more important. "Time was when pure science always came first, with the engineer then seeking practical applications for the findings of the "ivory tower" scientists." To make possible the conduct of scientific research in space, about 85% of all effort is directed toward the solution of engineering problems. The essentially engineering functions support the work of the experimental scientist as he seeks out new knowledge of the universe.

In a recent speech, Dr. Werner von Braun stated the following: "More is unknown than is known. Much of what we have done, much of what is expected of us, strains the state of the art to the breaking point. We must design and fabricate vehicles that can function for months and years under conditions which do not exist on earth. We must use materials that will be exposed to extreme vacuum, to high radiation activity, and to other extraordinary phenomena encountered in space. The hypersensitive guidance and control systems that steer these fire-breathing monsters must operate over long periods under great stress without any possibility of repair or maintenance. Standard Oil has yet to establish a service station in space"

"We must have power supplies characterized by light weight and long life. We need propulsion systems of far greater thrust than is yet available. We must develop systems that will permit maneuvers in space. We must acquire a better understanding of celestial mechanics to refine space trajectories. We must think in terms of achieving reliability as of utmost importance before we can safely entrust human life to our space ships."

Notice that these problems facing us as we attempt to conquer space are, in the main, engineering problems. We must recognize the need for facing up to the problems of training a new breed of engineers—a breed that will be well prepared to meet the technological challenges of the coming decades.

How is education meeting the challenge? The Ford Foundation re-

(*Continued on page* 34)

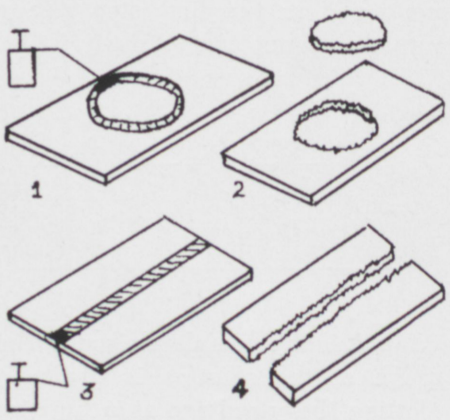
Explosive Cutting

By Hal Booher, sr., e.e.

A new method for metal cutting has recently been introduced in industry. Flexible sheet-explosive is presently being manufactured by E. I. du Pont de Nemours & Co. The sheet explosive is termed EL-506 A (made of PETN — pentacrythretal tetranitrate), and can be cut with a regular linoleum knife. It is simple to use, inexpensive, and does a satisfactory job of cutting in most cases. To insure the correct amount of explosive in the right place the sheet is cut with a knife and then molded to fit the contours of the work.

There are a few precautions to consider when using the sheet explosive as with any explosive, but it is relatively safe to handle. An 18 oz. ball dropped from ten feet onto the material won't detonate it; neither will throwing the sheeting into a wood fire or firing a 30 caliber bullet from 15 yards into it. A high-powered electric blasting cap is the most effective means of detonation.

The main advantages of sheet explosives are (1) maximum cutting with minimum weight of explosive unit needed, (2) simple to apply, (3) safe to handle, store, and install, (4) reliable because few connections are required, (5) uniform amount of explosive over area to be cut.



One big disadvantage is that cuts are shaggy and need cleaning up after the blast. Because of its form and degree of safety, other uses are quite feasible, such as prehardening of castings and parts.

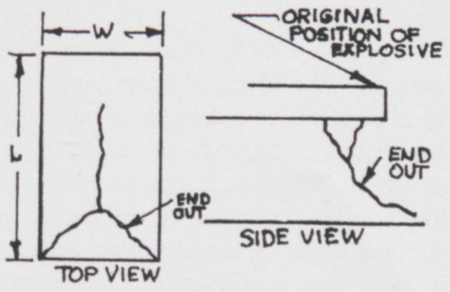
Required unit load can be obtained by combining a number of sheets. Sheets placed on both sides of a metal sheet will have the same cutting effect per unit explosive load as sheeting placed on just one side of the metal. To be assured of maximum utilization of the detonation pressures, the explosive sheet and the metal must be closely bonded. This is accomplished by applying adhesive to both the sheet and the material to be cut.

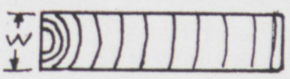
One method of explaining how explosive cutting works is by treating the metal hydrodynamically and using linearized approximation and assuming the metal splits wherever the pressure becomes sufficiently negative. Negative pressures occur when two rarification waves meet. Consider first Fig. 2. If the strip of explosive is not too wide, only one split will result when the cap explodes, and a detonation wave front is set up.

The approximations assumed for linearized approximation analysis are as follows:

1. The shock front of the metal is straight and carries a constant pressure at time $t = t_o$.
2. Principle of superposition holds true.
3. The detonation front flow is made of two parts, constant along the lines $y = ax + b$ and $y = -ax + b$. $y = O$ for x greater than O, and $y = -y_o$ for any x along the metal surface; atmospheric pressure being considered zero. See Fig. 3 for conditions at $t = t_o$.

The pressure along $y = o$ for x less than O is determined by the explosive-metal boundary conditions. As time goes on, the pressure and velocities behind the shock front are the sum of the functions constant along $y = ax + b$ and $y = -ax + b$. The pressure is zero





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ANALOG

The analog computer is an important tool of modern science. One of the elements of an analog computer is a multiplier. Multipliers have lacked the good characteristics of other computer elements, and hence work has been done to perfect better units. One of these new units is the Hall Effect multiplier.

This report explains the operation of an analog computer and how the multiplier is used. The Hall Effect, and how it can be used to multiply, is shown. The conclusion goes into the problems and modifications involved in the experimental Hall units built so far.

ANALOG COMPUTERS

The analog computer is usually a device for solving differential equations. It consists of an electrical circuit. It operates by an analogy between this circuit and the differential equation.

Principle

An analogy is a "similarity in some respects of things otherwise unlike". In the computer's analogy, the things unlike are the differential equation and the electrical circuit. The similarity is in the behavior of the variables of the equation (x and y) and the variables of the circuit (a voltage and time). The circuit is designed so that the mathematical relationship between x and y will be the same as that between the voltage and time.

The solution of a differenital equation is generally an algebraic equation which can be graphed in the usual manner. The solution, as it comes from the computer, is expressed not as the equation, but as the graph.

The computer itself is a set of components which are wired together to form the circuit. This circuit is wired differently for every equation. A circuit for solving a linear differential equation with constant coefficients will consist of constant multipliers, sign changers, summers, and integrators.

These elements produce a voltage that is graphed as a function of time. This graph is identical to that of the solution to the equation.

Example

A simple example will show how these are set up. Consider the first order first degree equation:

$$\frac{dy}{dx} + y + A = O$$

or

$$\frac{dy}{dx} = -y - A$$

Analogies are made so that the constant A and variable y are represented by voltages with respect to ground, and x is represented by time.

$$\frac{dy}{dt} = -y - A$$

First we see that $\frac{dy}{dt}$ is the negative sum of y and A. This operation, on the computer, is shown in Fig. 1.

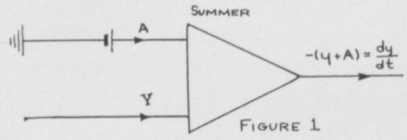

FIGURE 1

Here A is from a constant voltage source. The source of the y voltage will be explained later. Because of the nature of the internal summer circuit, the sign is automatically changed.

Now if we integrate $\frac{dy}{dt}$ we will get y. Again the sign is automatically changed by the integrator giving

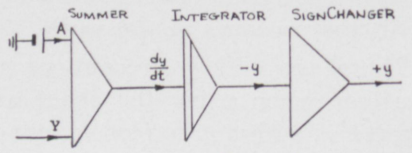

FIGURE 2.

$-y$. Therefore, to get $+y$, we must change it again. Fig. 2 shows these operations added to Fig. 1.

The constant of integration is supplied by the integrator.

To complete the circuit, and to provide a source for the y voltage mentioned in the first step, the y output is connected to the y input.

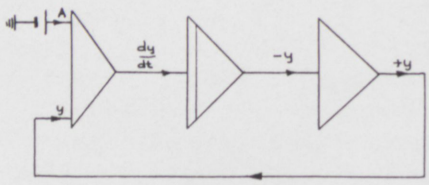

FIGURE 3.

Fig. 3 is the complete circuit. The graph of the solution is made by plotting the y voltage as a function

COMPUTERS

By Dean Brown, sr., e.e.

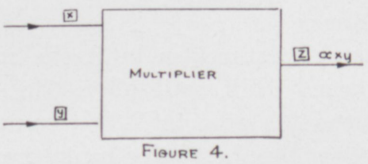

FIGURE 4.

of time. This can be done on a roll paper plotter or on an oscilloscope.

Higher order linear differential equations with constant coefficients are solved by a more involved circuit with the same elements.

THE MULTIPLIER

To solve an equation of higher degree than one, or one with variable coefficients, a multiplying device must be used. This device can be represented as in Fig. 4. Here x, y, and z are all variables

It is not necessary that z = xy because constant multipliers can correct z oc xy or z = xy by multiplying xy by k.

ELECTRONIC MULTIPLIERS

Many types of electronic multipliers have been devised and used. However certain drawbacks limit their use. The multipliers have been either slow, inaccurate, overly large, complex, or expensive. Many have more than one of these drawbacks.

This is contrasted with the operating devices used in solving linear differential equations. Summers, integrators, etc. have been known for some time, and their design has been brought to a high stage.

A new principle may allow the multiplier to be brought more nearly to perfection. This principle consists of utilizing the Hall Effect in semiconductors.

THE HALL EFFECT

A magnetic field causes a force on a moving charge. In Fig. 5 (three dimensional) this is shown. The vertical arrows represent the magnetic field B, and the dotted arrow shows the path of a moving positive charge. The moving charge will have a force exerted on it in the direction of the short horizontal arrows.

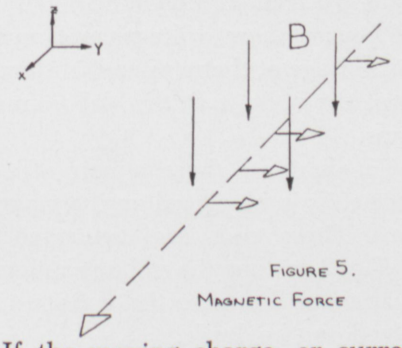

FIGURE 5.
MAGNETIC FORCE

If the moving charge, or current I, is contained within a slab of material, the moving charged particles will be pushed over to the side of the slab. Because of this, if a voltmeter were connected from one side of the slab to the other, it will read a voltage. This is shown in Fig. 6. This voltage phenomenon is known as the Hall Effect.

It can be shown that

where V_y is the voltage across the slab, the Hall voltage,

Rh is the Hall coefficient, depending upon the slab material,

B is the magnetic field,

I_x is the current through the slab,

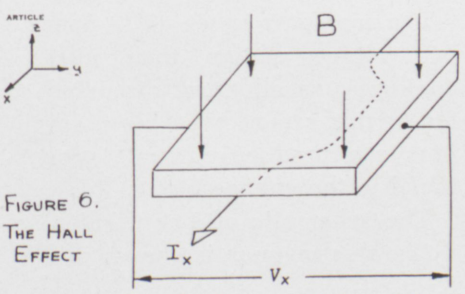

FIGURE 6.
THE HALL EFFECT

and z is the thickness of the slab. As used here, the subscripts indicate the direction of measurement of the quantity on the Hall slab.

Until recently the Hall Effect has been of little importance because the Hall coefficient Rh of metals is extremely small. However modern developments in semiconductors have provided several materials which have a usable Rh.

THE HALL MULTIPLIER

Principle

If, in equation 1, the Hall coefficient Rh is considered constant (which is almost exactly true in many cases) we have the proportion

$$V_y \text{ oc } BI_x$$

Here we have a voltage proportional to a product. Therefore this phenomenon can be used to multiply.

The multiplier is built with an electromagnet to supply the magnetic field B as shown in Fig. 7.

If the core is made of a material with constant permeability

$$B \text{ oc } I_m$$

Substituting this into proportion (2).

$$V_y \text{ oc } I_x I_m \qquad (3)$$

Current Analogies

From the above the Hall voltage is

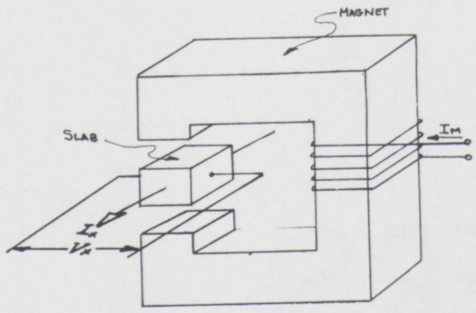

FIGURE 7.

proportional to the product of two currents. With the proper analogies, proportion 3 becomes

$$z \text{ oc } xy$$

This is the general multiplier equation as expressed in Fig. 4.

If a computer is set up to operate on voltage rather than current analogies, as all those discussed so far in this report have been, amplifiers can produce currents proportional to the voltage inputs.

The schematic of a multiplier set up in this manner is shown in Fig. 8.

For some uses a current rather than voltage output is desired. A current I_y can be drawn across the slab so that

$$I_y = \frac{V_y}{r}$$

(r = total resistance of the circuit) This would operate satisfactorily if r were constant. However the slab resistance (a part of r) varies somewhat with B, and this introduces some inaccuracy to the system. Special construction can reduce this.

Another requirement for a current output semiconductor is a fairly low resistance. This can be obtained by using a slab of a material with a high mobility .

Semiconductor Materials

Four materials have been used as semiconductor slabs. These are germanium, silicon, indium antimonide, and indium arsenide. The first two have a high Hall coefficient Rh, making them very sensitive, but they have a low mobility . This makes these suitable for voltage output multipliers, but their resistance is too high for current output devices. On the other hand the two indium compounds have a high mobility but are not so sensitive. Indium antimonide's use is limited by a large temperature variation or its response.

EXPERIMENTAL HALL UNITS

Several experimental Hall multipliers have been built. In the construction of each, problems arose and were solved.

Lead Induction

One of the earlier problems was successfully eliminated by Keister. Because the leads to the slab, as well as the slab itself, are in a magnetic field, as the field changes small voltages will be induced in these leads by transformer-like induction. Of course these voltages will make the voltage at the wire ends different from the voltage at the slab connections.

To eliminate these a pair of two turn coils were placed on the magnet core. These coils are connected as in Fig. 9 so that the voltage induced in them will oppose the voltages induced in the leads.

Hysteresis

To derive the proportion

$$V_y \text{ oc } I_x I_m \qquad (3)$$

it was assumed that the field B was proportional to the magnet current I_m. This is not exactly true because the permability of a metal magnet core is not constant.

This error has been greatly reduced by using a core material with low hysteresis losses. Chasmar and Cohen initiated the use of "Ferroxcube A.1".

Besides having an almost constant permeability, Ferroxcube has a high resistivity. This enables the core material to rest directly on the slab surface without any separating insulation. Therefore the magnetic circuit's reluctance will be minimized, and the magnet current I_m may be lower for a given field B.

Feedback

Lars Lofgren has built the most advanced Hall multiplier. He has reduced his eror to O.1%, comparable to the best electronic multipliers, and better than most.

Lofgren attains this great accuracy by correcting his errors with a feedback system. The circuit is shown in Fig. 10.

In the magnet gap there are two identical semiconductor slabs. Through one of them runs a constant current I_c. Therefore this slab's output voltage V_c should be

$$V_c \text{ oc } I_c I_m$$

Since I_m is proportional to y, and I_c is constant, V also should be proportional to y.

V_c is fed into the field amplifier where it is compared with y. If it is not proportional to y, the amplifier will adjust I_m to make it so.

For example, if the amplifier and I_c were adjusted so that V_c should be 0.ly, and if actually V_c were .90y, the amplifier would increase I_m, and thus increase V_c.

Thus the feedback system can correct all of the errors in the control slab, field magnet system, so that

$$yK \text{ oc } y$$

(where K involves I_c, Rh, and the amplifier characteristics) will exactly be true.

At the other slab the same corrections will apply. The constant current I_c is replaced by a variable current I_x. In this slab, instead of

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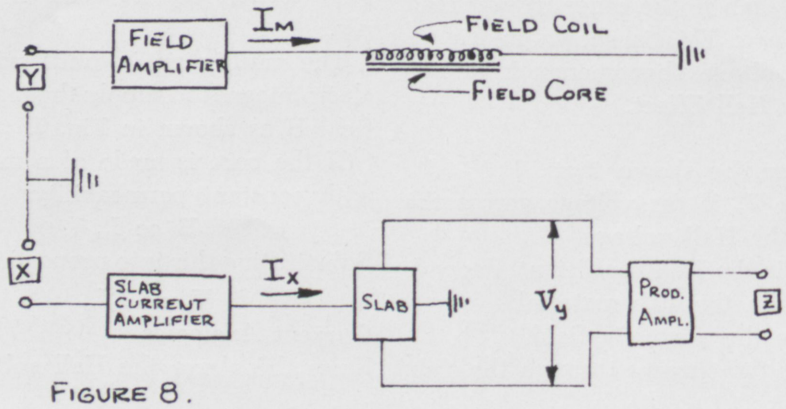

FIGURE 8.

Research and Development

By Jon Modesitt, frosh.

An amazing new super-crystal has been discovered which may be acclaimed to make the transistor look like an antique. This new discovery is the "tunnel diode." The tunnel diode, although not yet in mass production by any company yet, is an invention of Dr. Leo Esaki of Sony Corp. in Japan. The tunnel diode has many good features that may bring about many new realms of electronics not yet realized. One feature of the diode is that it is quite inexpensive. It is made out of scraps that might be thrown away in the manufacture of transistors. The diode also is an ideal fit in the modern trend of miniaturization because it is small enough that the entire diode would get lost in a paper clip. The diode operates on one thousandth the power required by a transistor, and a hundred thousandth of the power demanded by a tube. The diode will also prove valuable in many fields because of its ability to handle all frequencies. The tunnel diode is also the quietest amplifier in the respect of static elimination. The use of tunnel diodes in television receivers would enable TV stations to increase their range and put more stations on the air at frequencies that at the present time can not be received. The development of tunnel diodes may also bring about many new products such as car telephones, portable F.M. pocket radios, battery powered TV sets and many various communication systems for use in space travel.

This new magical diode is a product of quantum physics. The basic performance of the diode gives an increase in resistance with an increase in voltage, which is the opposite of what normally happens. This performance of the diode, along with its ability to handle high frequencies, and low noise output, combined with a low cost, may revolutionize many important fields of electronics.

A new visual aid for use in conferences, lectures, or classes has been introduced by Staples-Hoppman Inc. The new multi-purpose rear view projector introduced utilizes several methods of visual aid in its composition. The projector is in the form of a large TV set. The conference leader has his choice of utilizing movie film, slide projection and his own audio portion through the device. The projector is operated from a removable remote control panel which enables the instructor to switch from movies to stills and back to movies; he may also use movie sound or his own narration by simply pushing the required buttons.

The projector is contained in a compact movable self-contained unit. The ability to view the projector in normal lighting is another valuable asset of this new projector. The projector is available with a 25x34 inch screen or a 35x48 inch screen.

A NEW OVEN

Where ovens are employed for any use there usually exists a problem of maintaining a constant temperature for a set period of time. The American Instrument Company, Inc., have developed a new oven which is acclaimed to accomplish the task of maintaining a constant temperature. The new oven has a capacity of four cubic feet and utilizes an all stainless steel interior. The consistency of temperature is achieved through the use of six electrical resistance heaters. In lab-

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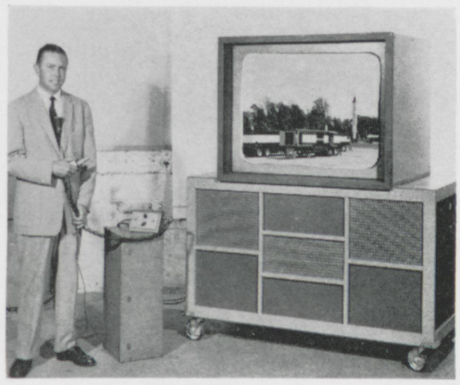
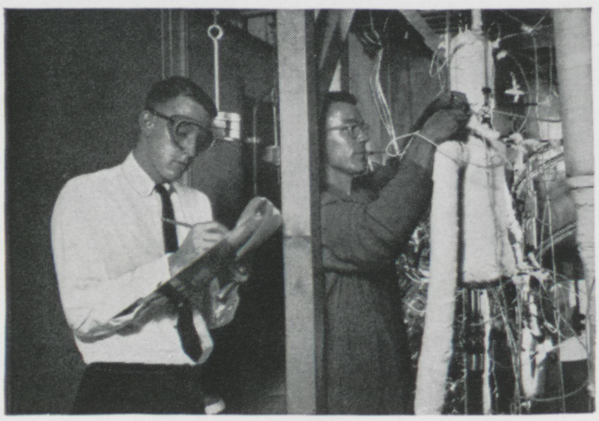


Remote Control Lecture Projector

engineers

Automatic systems developed by instrumentation engineers allow rapid simultaneous recording of data from many information points.

Frequent informal discussions among analytical engineers assure continuous exchange of ideas on related research projects.



Under the close supervision of an engineer, final adjustments are made on a rig for testing an advanced liquid metal system.

and what they

The field has never been broader
The challenge has never been greater

Engineers at Pratt & Whitney Aircraft today are concerned with the development of all forms of flight propulsion systems—air breathing, rocket, nuclear and other advanced types for propulsion in space. Many of these systems are so entirely new in concept that their design and development, and allied research programs, require technical personnel not previously associated with the development of aircraft engines. Where the company was once primarily interested in graduates with degrees in mechanical and aeronautical engineering, it now also requires men with degrees in electrical, chemical, and nuclear engineering, and in physics, chemistry, and metallurgy.

Included in a wide range of engineering activities open to technically trained graduates at all levels are these four basic fields:

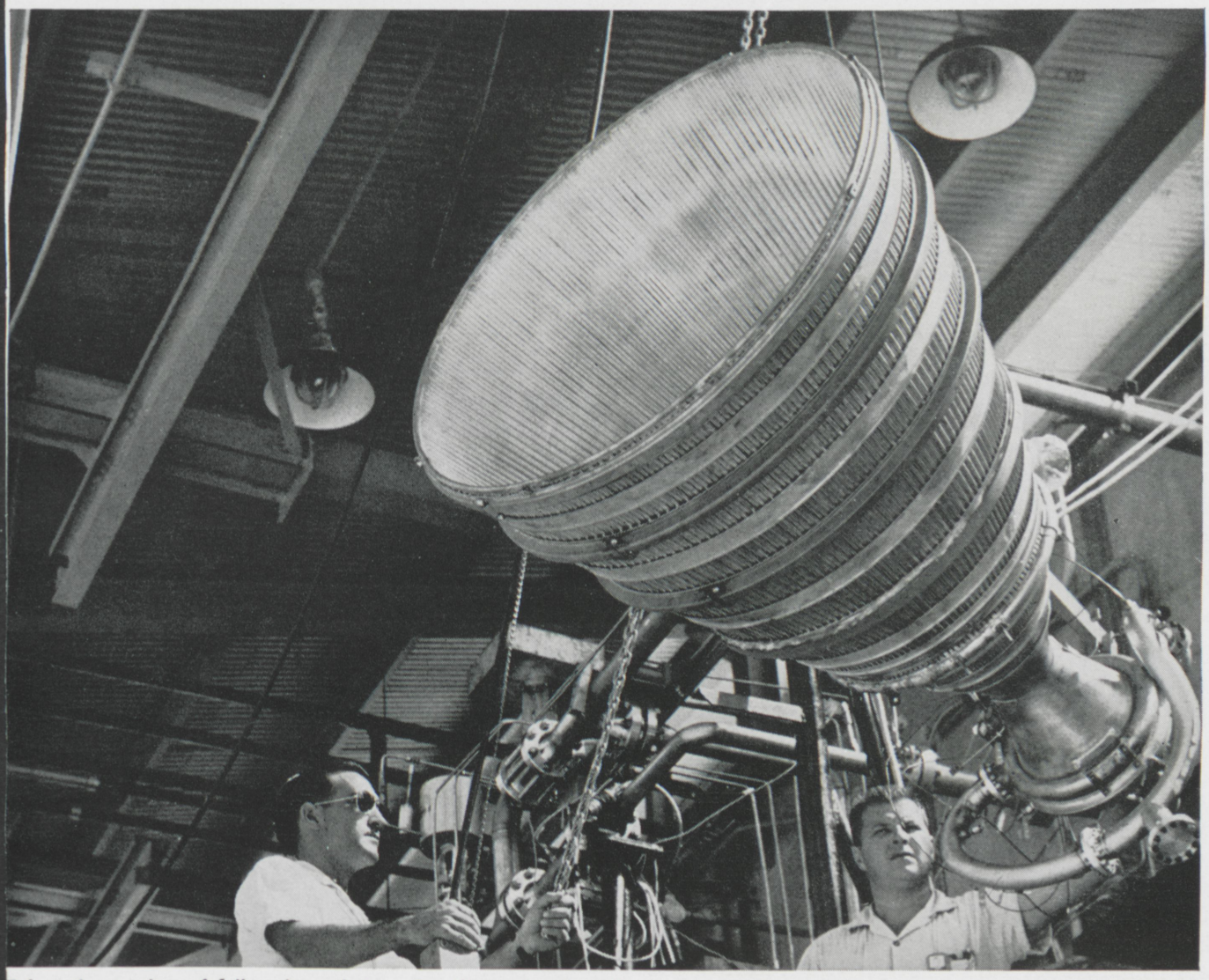
ANALYTICAL ENGINEERING Men engaged in this activity are concerned with fundamental investigations in the fields of science or engineering related to the conception of new products. They carry out detailed analyses of advanced flight and space systems and interpret results in terms of practical design applications. They provide basic information which is essential in determining the types of systems that have development potential.

DESIGN ENGINEERING The prime requisite here is an active interest in the application of aerodynamics, thermodynamics, stress analysis, and principles of machine design to the creation of new flight propulsion systems. Men engaged in this activity at P&WA establish the specific performance and structural requirements of the new product and design it as a complete working mechanism.

EXPERIMENTAL ENGINEERING Here men supervise and coordinate fabrication, assembly and laboratory testing of experimental apparatus, system components, and development engines. They devise test rigs and laboratory setups, specify instrumentation and direct execution of the actual test programs. Responsibility in this phase of the development program also includes analysis of test data, reporting of results and recommendations for future effort.

MATERIALS ENGINEERING Men active in this field at P&WA investigate metals, alloys and other materials under various environmental conditions to determine their usefulness as applied to advanced flight propulsion systems. They devise material testing methods and design special test equipment. They are also responsible for the determination of new fabrication techniques and causes of failures or manufacturing difficulties.

Pratt & Whitney Aircraft...



Exhaustive testing of full-scale rocket engine thrust chambers is carried on at the Florida Research and Development Center.

For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida

Fraternity

LAMBDA CHI ALPHA

Tom Feutz, the former author of this article, has been relieved by yours truly, Bob Amos. Tom's shoes will be difficult to fill—for as you know he has a talent for writing as well as being one of the Biggest Men On Campus.

The brothers of Theta Kappa may very well be proud of their recent scholastic achievements. This past semester we had the highest point ratio of any fraternity on campus in many years. We have also received notice from the Lambda Chi Alpha national office in Indianapolis that we were tops scholastically among the 150 Lambda Chi chapters in the nation for the 1958-59 school year.

Gale Hurst has been appointed coordinator in charge of planning and construction of the new Lambda Chi house. For the past few months, work on the preliminary plans has been progressing steadily. More on this later.

The chapter has elected as its new officers: Bob Checkley, president; Gale Hurst, vice-president; Jerry Hahn, secretary; Jim Gates, treasurer; Don Dekker, rush chairman; Bill Fenoglio, pledge trainer; Jerry Badger, ritualist; Larry Myers, social chairman; Phillips Ballantyne, house manager; Warren Griffith, steward; Fred Terry, assistant treasurer; and Andy Hrezo, assistant ritualist. In office since February, these men are doing a fine job of leading the chapter to new heights.

The fly-boys continue to have bad luck on the intramural basketball court. We lost a close one to Sigma Nu, 38-33 despite the stellar work of guards Bill Fenoglio and Bob Checkly.

Bill Fenoglio joins Don Dekker as co-editor of the Rose Tech Explorer. Bill (Trummy) Young has been promoted to business manager of the Explorer.

Jim Funk has become co-editor of the Technic. Other additions to the Technic staff are Don Bonness on Campus Survey and Jim gates as head of the features staff.

The brothers have been on the move socially of late. In the past month, Theta Kappa has had two very successful house parties. These mixers were with St. Mary's of the Woods, March 4, and the Gamma Phi sorority, March 11.

There has also been a noticeable upswing in dating among the brothers, especially the Big Four. These enterprising young men, who shall at present remain anonymous, have made a vow to extend their social activities this semester. It is suspected that some monetary or liquid wager has been made (probably the latter).

Until then—

Bob Amos

SIGMA NU

The big news this month concerns our new pledge class. Fifteen of the finest freshmen pledged Sigma Nu the first day. Our quota this year is twenty-two, and, as of this writing, we haven't filled our quota; however, this situation may soon change. The new pledge class is as follows:

Tom Davidson—Orland Park, Ill.
Rich Daughtery—Merom, Ind.
Tom Fite—Olney, Ill.
Joe Grumme—Terre Haute, Ind.
Neil Irwin—Greencastle, Ind.
Ray Lepp—Gary, Ind.
Bob Lovell—Mishawaka, Ind.
Brent Lower—Mishawaka, Ind.
Don Marietta—Blanford, Ind.
Jerry Niederhaus—Evansville, Ind.
Steve O'Neill—Terre Haute, Ind.
Don Pierce—Ft. Wayne, Ind.
Gib Robinson—Hobart, Ind.
Mike Sullivan—Fairfield, Ill.
John Toole—Evansville, Ind.

We at Beta Upsilon are very proud of our new pledges, and know that they will make fine actives.

Three pledges were initiated Sunday, February 14. They were: Wilbur Decker, Brazil, Ind.; Don Hurst, Terre Haute, Ind.; Dick Bennett, Vincennes, Ind.

Four of our men received class honors for the last semester. They were: Gary Anderson, Charles Smith, Ron Higginbotham, and Bill Yochum.

We played Butler (Epsilon Mu) a few weeks ago in the State Day Tourney, beating them 81 to 66; this means we will play I. U. (Beta Eta) in the final game on State Day, March 12. We're going there to WIN! In I-F competition, we have won three and lost one, now ranking second place. We still have our eyes on the championship, however.

That is all the recent news for

Notes

now, but we would like to remind all you Alumni to start making plans for our anniversary celebration, the date of which will soon be announced.

—Bob Carter

THETA XI

Several house improvements have been made during the month of February. The two second floor bathrooms have been remodeled and a new carpet installed on the front stairway.

The TX Tigers are currently leading the IF basketball race with a record of 5-0. Vern Gross, who led the Tigers in scoring last year, has been lending his talents to the varsity basketball squad.

Brother Dave Reese is Kappa's new social chairman, succeeding Ron Andis, who has been named chairman of the Simerall's committee. Back after a semester's absence are pledges Norman Crouse and Jerry Oxley of Borden and Wingate, Ind., respectively.

Bob McCardle has given his Badge of Honor to Miss Carole Wampler of Sullivan, Indiana. Another $3 for the Fund in now due.

Kappa Chapter was saddened to learn of the death of alumnus Jim Veach. Brother Veach was killed in an automobile accident near Princeton, Indiana, on February 4.

—Bob McCardle

APHA TAU OMEGA

With the big push of rush well behind us now we of Alpha Tau Omega have settled down to the business of school again for another year. The parties were highly successful, and congratulations are well in order for Brother Marshall Garino, rush chairman, for his fine handling of the event. Also to be commended for an excellent job is Brother Jerry Heiniger, house manager, who kept us hopping with a minimum of threats.

Alpha Tau Omega is proud to announce the new pledges who are wearing our pledge pins. Our new pledge brothers are: Tom Bosworth, Terre Haute; Richard Rapson, Terre Haute; Jack Spitler, Terre Haute; Jay Pollitt, Terre Haute; Jon Modesitt, Terre Haute; Larry Shaffer, Terre Haute; Bill Volkers, Terre Haute; Ned Hannum, Prairietown; Andy Breece, Indianapolis; Greg Mitton, Oaktown; Nick Kira, Indianapolis; Ron Danilowicz, Cleveland; and Bob Stoutenour, Orland Park, Illinois. Congratulations to you new men of ATO.

The annual State Day Convention for the four chapters of ATO in Indiana was held at Indiana University this year. Saturday, March 12 found the actives from DePauw, Purdue and Rose Tech converging on the Tau house in Bloomington. Highlighting the day was the banquet at which our national president of Alpha Tau Omega, Gerald E. Johnson, addressed the assembled chapters. The songfest and basketball games were centers of spirited competition as usual. The dance held that evening was successful for a large number of men from Gamma Gamma as the many filled pages in little black books will attest.

Since this seems to be as good a time for clearing up the congratulations due men of ATO, I'll take advantage of it for just that. With elections in the offing very soon it's time to say, "Well done!" to those men leaving the positions of leadership within the chapter. Seniors leaving are Worthy Master, Larry Berger; Worthy Chaplain, Ron Staggs; Worthy Keeper of the Exchequer, Bill Perkins; Worthy Keeper of the Annals, Dave Trueb; Worthy Scribe, Bob Schukai; Worthy Uusher, Louis Roehm; Worthy Sentinel, Ted Jaenke; Fiscal Assistant, Jon Stiles; and pledge trainer, Woody Stroupe. With leaders such as these in the future, ATO is certain to continue to expand and improve with every year.

The interruptions of rush have subsided enough to permit the interfraternity basketball rivalries to start with anewed vigor. Sporting an unimpressive won-loss record we Taus are determined to come back strong in the remainder of the season and avenge some of those scratch victories the opposition scored against us.

Plans for Goodwill Help Day are well along the way toward completion and with a little help from the weather man it should go smoothly. As has been the procedure in the past, the four fraternities will pass the bags out together, and we will collect the full ones two weeks later.

—Bill Carter

Campus

Finals have tolled the knell of the first semester of this 1959-60 school year. With the old semester behind us, we resolve to study harder to bring our "cums" up.

Freshman grades this past semester were higher than they had been in several years. This writer believes that this is partly the effect of the required study hours in the library for those students having D's and F's in courses. Congratulations are in order to the administration, especially to Dr. Morgen and of course to the freshman themselves.

COMPUTER CENTER AT ROSE

The current presence of the computer in the electrical lab. has attracted the interest and curiosity of many faculty members and students alike. Indicitive of this interest is the fact that this mathematical manipulator always seems to be in use.

A computer center at Rose seems almost certain in the very near future. Half of the funds for such a center were provided by the Edward G. Walters Fund while the other half has been requested from the National Science Foundation. The committee which has directed the planning of the center, to be called the Edward G. Walters Computer Center, is made up of Rose faculty members: Professors Palmer (director), Criss, Pao, Guthrie, and Maudlin. This committee has investigated many computers in order to choose the one which best fits the need and financial status of the center. At the time the committee was founded, the choice seemed simple due to the fact that there were only two computers which were in the desired price range; but since that time, the computer field has expanded rapidly. Having analyzed at least 15 different models, the computer committee made extensive studies of four machines. Last spring a Royal-McBee LGP-30 computer was on campus for a one-week trial, and at present a Bendix G-15 is being put through its paces by faculty members and students on another free trial. Among the other computers considered by the committee are the following: the IBM-1920, the RECOMP-2, the Univac, Model O, and the Royal-McBee, RPC 4000. The latter is a larger scale machine than other computers of the moderate price range. It has many characteristics which are very appealing to the committee; its only disadvantage seems to be the fact that it is so new that the committee has not yet examined it. Of course, the final decision in the choosing of the machine will rest with the National Science Foundation.

The purposes of a computer center at Rose are three fold: first, for instructional use. Although there is no intent to train technicians as operators, in the immediate future a great number of engineering graduates will find computers under their supervision. It is, therefore, very desirable for the engineer to have some training in the functioning and use of computers. Secondly, the machine will be available for research to faculty members and students, especially for graduate work. And last, the computer might prove useful to various local industries in their research projects. No

Survey

By Don Bonness, soph., e.e.

attempt will be or has been made to "push" this service, but seems likely that it will follow.

The computer center will not only be a great asset to Rose, but it will also be very advantageous to the industry in the surrounding area.

US vs. USSR

On February 11, Dr. Donald J. Hughes, Senior Physicist at Brookhaven National Laboratory in Long Island and former member of the Manhattan Project's A-bomb army of scientists at the University of Chicago, spoke to the student body on the controversial subject — Russian science. Having traveled through the Soviet Union and having examined the science situation there, Dr. Hughes is well qualified to speak on this subject.

In his discussion, he compared Russian science and scientific education with that in the United States. Dr. Hughes stressed the importance of basic research as a means of staying ahead in the "science war". Although sometimes hard to justify since it is not programmatic, basic research leads directly to applications in many fields of science. Two recent and important examples are atomic power and transitors. Dr. Hughes contends that we are well ahead of the USSR in basic research although we do lag in applied science. This is due to the difference in political systems, Russia's system makes it possible to turn out large numbers of trained scientists and to raise money for scientific projects with ease; therefore Russia is ahead in fields which depend upon large sums of money and large numbers of scientists. Our democratic system fosters imagination and the right to criticize, which are vital requisites for basic research projects.

Dr. Hughes believes the main problem is one of democracy verses dictatorship. Our government's purpose is not merely to survive but also to guard our way of life, but we must survive. Three necessities for survival and the protection of our system were outlined by Dr. Hughes: First, we must build modern weapons and a modern army so Russia will not attack. Second we must promote basic research to stay ahead of the Russians in new developments. And last, we must give our citizens a better education in science so that they may better understand the world situation.

SPARKETTES PERFORM AT ROSE

Between halves of the Rose-Principia basketball game of Saturday, February 13, the "Sparkettes" a newly formed precision dance group, went through their paces. Everyone at the game enjoyed the fine entertainment provided by these pretty belles from Indiana State Teachers College.

The group seemed to be a drawing card as the attendance to the game was significantly improved over previous games. This improved attendance probably had much to do with the fine showing by the team in beating Principia by thirty points. It would seem advantageous for the team and for school spirit in general to have such entertainment at as many home games as possible. Perhaps we could have the "Sparkettes" back soon.

Alumni News

By Larry Shaffer, frosh.

Doctor C. Chester Stock, of the class of 1932, who is working with the Sloan-Kettering Institute for Cancer Research, will assume the responsibilities of scientific director for that Institute in the spring. He has served in the chemotherapy division and lately as associate director.

Formerly from Terre Haute, Dr. Stock was graduated from Garfield High School in 1928. He then came to Rose and succeeded in earning the honored Hemingway Award. John Hopkins University graduated Chester Stock with a Ph.D., after which he received a Master's degree in medical bacteriology from New York University. Rose Poly awarded him an honorary Doctor of Science degree in 1954.

His professional career before joining the Sloan-Kettering Institute consisted of instructing in bacteriology at New York University, working for the Rockefeller Institute Hospital, and serving as technical aide for the committee on medical research of the Office of Scientific Research and Development. He was also a member of the experimental therapeutics study section of the United States Public Health Service.

Dr. Stock is a member of several organizations including the New York Academy of Medicine, American Chemical Society, American Association of Cancer Research (of which he was a director in 1955), the Harvard Society and many others. His memberships include Sigma Xi, Tau Beta Pi, Lambda Chi Alpha, and Blue Key.

Many of the alumni will remember his father, Professor Orion Stock of Frankfort, Michigan. Orion Stock taught in the drawing department of Rose for more than 40 years.

The Rose Technic wishes to congratulate Dr. C. Chester Stock on his success and to extend best wishes to him on his future job.

Art Nehf, former New York Giants pitcher and Rose graduate has recently been released from Memorial Hospital in Phoenix, Arizona. (He is featured in an article in the present Rose Alumni Quarterly.) Since publication of the Quarterly, we have received the information that he underwent surgery for cancer of the intestines on January 19th. Mr. Nehf remained on the critical list for a week. It is reported by his wife that he is improving steadily, although progress is slow. It is felt that he will be able to return to a fairly normal condition soon. All Rose wishes a quick recovery to a truly great "alum".

Note to Alumni:

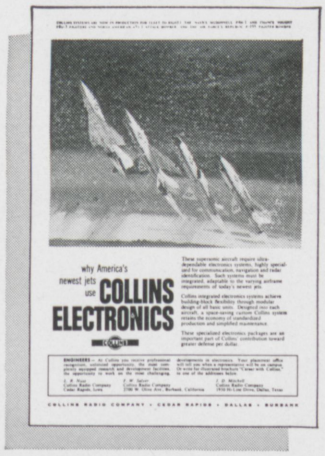
Dr. Morgan recently made a request of the Rose alumni for comments on "the weak and the strong points of their education in the light of their own experiences" so that Rose might benefit from the comments and "continue to be the experimental leader in engineering education." The Alumni News would enjoy publishing a few of these articles which might especially be of benefit to the students and faculty. We hope that the alumni will cooperate, for Rose and its future students will grow from these past experiences.

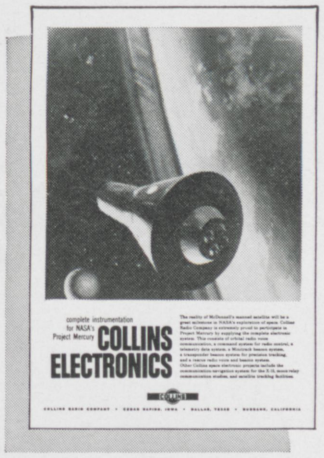
John W. German of the class of 1949 recently succumbed to a heart attack. He was employed by the U. S. Patent Office as a patent examiner.

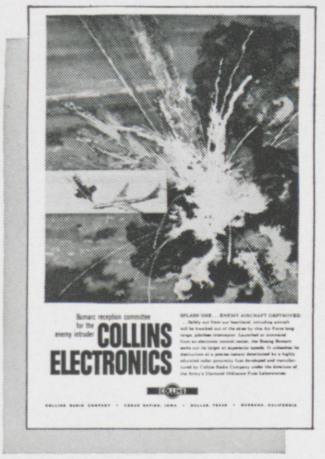
Note from Alumni News Editor:

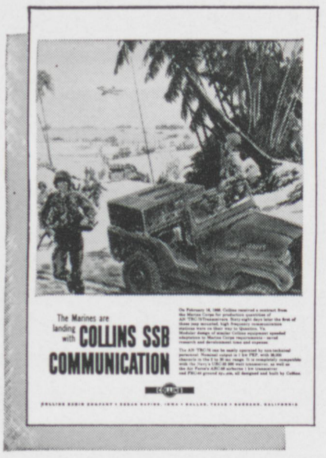
This editor has found in past articles that much information distributed to the alumni through this feature has often times repeated what was conveyed through the Alumni Quarterly. To deviate from this practice, there has recently been a series of biographies written about one specific individual. The intention was the introduction of various alumni to the students. It is disheartening to find that these biographies were not widely read by the students. In the future, therefore, there will be a further attempt made to interest the students in the alumni in different ways. This deviation in emphasis will in no way detract from the fundamental purposes of the feature, which is to inform the alumni and students of news about the alumni.

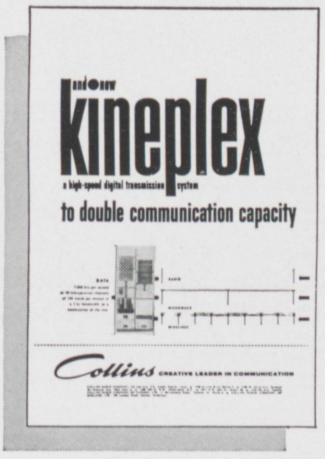
We would appreciate any information about any alumnus which would be of interest. The information does not need to be in the nature of a "success" article, but it would probably be more interesting to the alumni and the students if it were of a more general nature, such as philisophical experiences, travels, reunions, etc. Also, if the alumni have any requests for the type of articles which they would like to see printed in this feature, we should be glad to hear from them.

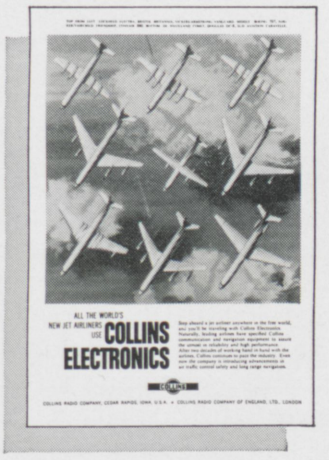












COLLINS ELECTRONICS— diversification

These specialized electronics systems are an important part of Collins' contribution to advancements in military and commercial communication.

Collins was selected over several companies because it could do the job — economically, with excellent equipment, and provide capable engineering assistance for all phases.

Collins needs engineers and physicists to keep pace with the growing demand for its products. Positions are challenging. Assignments are varied. Projects currently underway in the Cedar Rapids Division include research and development in Airborne communication, navigation and identification systems, Missile and satellite tracking and communication, Antenna design, Amateur radio and Broadcast.

Collins manufacturing and R & D installations are also located in Burbank and Dallas. Modern laboratories and research facilities at all locations ensure the finest working conditions.

Your placement office will tell you when a Collins representative will be on campus.

For all the interesting facts and figures of recent Collins developments send for your free copies of *Signal*, published quarterly by the Collins Radio Company. Fill out and mail the attached coupon today. You'll receive every issue published during this school year without obligation.

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Library Notes

By Carson Bennett and Anita Jackson

DR. WHITE LIBRARY

We recently received the personal library of Dr. John White. This fine collection has added many valuable volumes to the Rose Library.

NEW PERIODICALS

To supplement the list of new periodicals appearing in the February *TECHNIC,* we have the following to add. (For a complete listing of the magazines received in the library, see the February Library Newsletter.)

Journal of Mathematical Physics—This journal is devoted to mathematical methods for the solution of physical problems as well as original research furthered by such methods. Topics include mathematical aspects of quantum field theory, statistical mechanics of interacting particles, new approaches to eigenvalue and scattering problems, theory of stochastic processes, novel variational methods, and theory of graphs as well as review papers on mathematical topics for physicists.

Muzzle Blasts—Official magazine of the National Muzzle Loading Rifle Association.

FROM THE NEW BOOK SHELF

The month of March is here again bringing with it the birthday of the patron saint of engineers, St. Patrick. Let us tell you a little about a biography of St. Patrick which we have in the library called *The Steadfast Man* written by Paul Gallico.

Paul Gallico spent many months in Ireland steeping himself in the writings and life of St. Patrick before beginning this lively biography. By doing this he has been able to lift Patrick out of legend and show him as a living, breathing man.

Born in England in A.D. 385, Patrick was captured by invading Irish tribes as a boy. In his captor's pagan land he first heard the religious call. He escaped then to the Continent to begin years of intensive religious study. When he returned to Ireland he Christianized the country so successfully that he won both the respect of the pagan ruler and the blessing of the Pope.

In Paul Gallico's knowing hands, Patrick's story becomes a thrilling inspiration. *The Steadfast Man* is a rich, authentic, lovable, and often humorous portrait of one of history's greatest missionaries.

The Laugh's On Me, by Bennett Cerf

The name of Bennett Cerf is synonymous with sparkling wit. Once again he has collected the best of today's humor in a lively, entertaining book—a book filled with hearty, hilarious reading—a handy reference for speakers, toastmasters and anyone else who needs a good story to tell.

Here are 2,000 anecdotes told in the inimitable Cerf style and conveniently arranged in 100 different categories as diversified as the battle of the sexes and hillbillies, or Hollywood and railroads.

This is a book as gay and refreshing as spring—warm and glowing as a winter fireplace. *The Laugh's On Me* will find a permanent, year-round place on every reader's bookshelf.

The Ivy Trap, by Douglas Angus

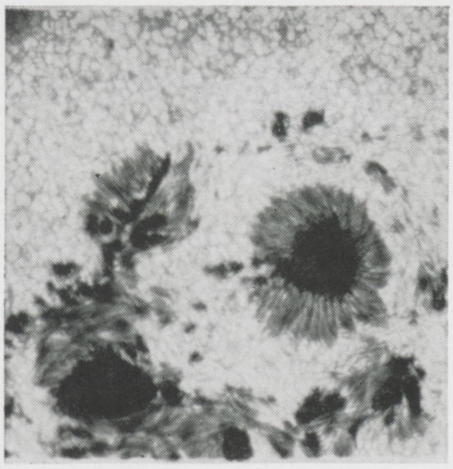
Allen Hazard was a doomed man — doomed by the all-too-human weakness that led him into indiscretions, into the destruction of the model world he had striven to make for himself, for his wife, for his two children.

Challenged by the Satanic delusion that he must defy convention and authority, and by emotions that as a man he could not stifle, he found it impossible to elude the trap of a confused sense of values. He himself foresaw that there could be no bright future for him. Yet he persisted. Here is a searchingly honest, persuasive study of a distinguished, learned, vital man, too commanding to be immune to the desire for self-destruction, too weak to master it.

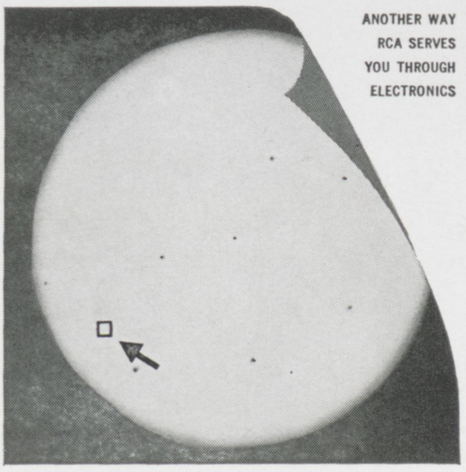
The Ivy Trap is more than a record of the plight of a single man. It has a universal quality in that Allen Hazard is a true representative of one of the most basic conflicts in al human nature. This is a tense and gripping story of a dramatic climax that will keep the reader guessing and reflecting for a long time to come.

(*Continued on page* 38)

Going up for "good seeing." Unmanned balloon-observatory starts its ascent to take sunspot photos. "Project Stratoscope" is a continuing program of the Office of Naval Research and the National Science Foundation.



One of the sharpest photos ever taken of sun's surface. It, and hundreds of others taken by stratoscope, may answer mystery of violent magnetic disturbances on earth.



Exact position of photograph in relation to the total sun surface is shown here. Plotting and photography of precise areas was made possible by airborne RCA television.

RCA REPORTS TO THE NATION:

REMARKABLE NEW PHOTOS UNLOCK MYSTERIES OF SUN'S SURFACE

Special RCA Television, operating from stratosphere, helps get sharpest photos of sun's surface ever taken

Scientists recently took the first, sharp, searching look into the center of our solar system. It was achieved not by a missile, but by a balloon posted in quiet reaches of the stratosphere.

The idea was conceived by astronomers at the Princeton University Observatory. They decided that a floating observatory—equipped with a telescope-camera—would offer a stable "work platform" from which sunspots could be photographed free of the distortion caused by the earth's atmosphere.

But "Project Stratoscope" encountered an unforeseen and major obstacle on its initial flight. A foolproof method was needed for aiming and focusing the telescope of the unmanned observatory. Princeton asked RCA to help.

A special RCA television system was devised which enabled observers on the ground to view exactly what the telescope was seeing aloft. This accomplished, it was a simple matter to achieve precise photography—directed from the ground by means of a separate RCA radio control system.

The resulting pictures reveal sunspot activities in unprecedented detail. They provide the world with important information regarding the magnetic disturbances which affect navigation and long-range communications.

The success of "Project Stratoscope" is another example of RCA leadership in advanced electronics. This leadership, achieved through quality and dependability in performance, has already made RCA Victor the most trusted name in television. Today, RCA Victor television sets are in far more homes than any other make.

RADIO CORPORATION OF AMERICA

THE MOST TRUSTED NAME IN ELECTRONICS

Locker Rumors

By Bob Michael, jr., e.e.

After a slow start this season, the Engineers are finally starting to show some promise. This is evident from the increase in the spirit and desire of the team members. They now look and play like a basketball team.

Jan. 15 found the Engineers at Greenville, Illinois, to play Greenville College. The first half of the game was a see-saw affair with Rose on top at half-time, 39-35. However, in the second half, the Engineer offense stalled and Greenville came from behind in the final eight minutes to score the victory, 83-73. Mike Smith showed excellent form as he led the Rose scoring with 20 points.

Back on their home court, Rose tangled with Concordia in an attempt to avenge an earlier defeat. The score was close all the way through the game, with neither team ever counted out. The Engineer's final drive in the closing minutes of the game netted them the victory 54-50, with Mike Smith again taking scoring honors with 15 points.

During semester break, the team went on the road. Their first stop was Oakland City College. After a fairly close first half, the Oakland City boys opened up with their big guns and ran away with the game. When the smoke had cleared, the score board read 108-66. This was truly a bleak day for the Fighting Engineers.

Two days later, Rose was in Carlinville, Illinois, to play Blackburn College. Fighting mad were the Engineers and a victory was what they were seeking. From the very beginning Rose took command and never relinquished the lead. With Phil Chute, Ron Jennings and John Ray hitting in double figures, the Engineers walked off the court with a 65-36 victory in very elated spirits.

Principia was the next stop for the team. The first half saw little action, but ended with Principia ahead, 39-25. After the intermission, both teams settled down and played a balanced game. The lead which Principia had built up carried them in the second half and the final whistle showed the score to be 73-58.

When Oakland City came to town the following week, the Engineers were ready for them. Playing their best game of the season, the team combined a good scoring game with alert defense. At half-time the score was all tied up, 30-30. The second half was tremendously exciting with fine play being demonstrated by both teams. At the end of the game, everyone gave a sigh of relief and cheered the Engineers on their 73-70 victory. Ron Jennings, Don Dekker, and John Ray led the scoring with 16, 13, and 13 points respectively.

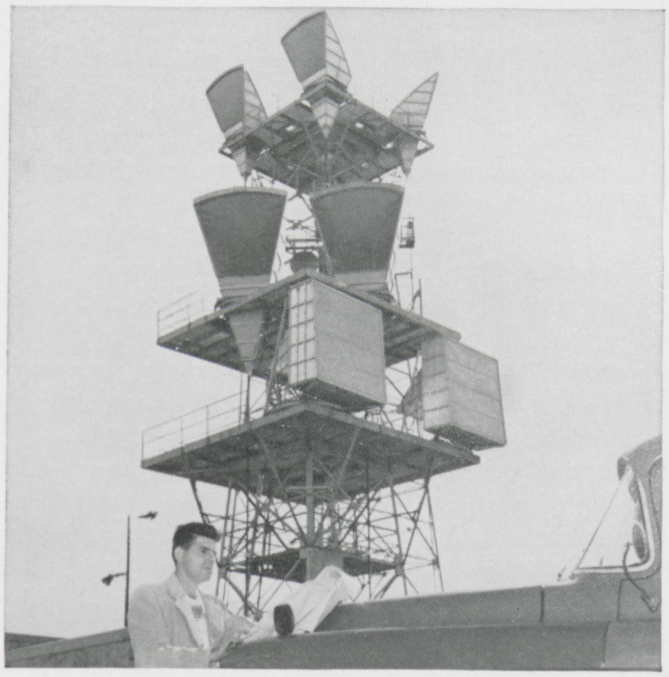
Fresh from a well-deserved victory over Oakland City, Rose met Principia with spirit and desire. By half-time the Engineers had netted a 32-21 lead. In the second half, Rose poured on the steam. By the end of the game, their margin of victory was 30 points with the final score reading 70-40.

On February 16, Vincennes was the opponent for the Engineers. The team once again displayed high spirit and desire throughout the game. At half-time they had a four point lead, 36-32, only to see it vanish in the opening minutes of the second half. For the rest of the half, both teams battled for the lead. As the final minutes ticked off, Vincennes took the lead and could not be overtaken. The final score of a well-played game was 74-70. Woody Stroupe, who played an excellent game, took scoring honors with 17 points.

INTRAMURALS

With the winter intramural sports program nearing an end, the competition is even more keen. All teams are fighting for the leading position and those points for the "all intramural" trophy. This trophy is given to the team that amasses the highest total number of points throughout the entire intramural program.

(*Continued on page* 33)



Dick Ernsdorff studies a microwave site-layout chart atop a mountain near Orting, in western Washington state. On assignments like this, he often carries $25,000 worth of equipment with him.

Here, Dick checks line-of-sight with a distant repeater station by mirror-flashing and confirms reception by portable radio. Using this technique, reflections of the sun's rays can be seen as far as 50 miles.

He wears two kinds of work togs

For engineer Richard A. Ernsdorff, the "uniform of the day" changes frequently. A Monday might find him in a checkered wool shirt on a Washington or Idaho mountain top. Wednesday could be a collar-and-tie day.

Dick is a transmission engineer with the Pacific Telephone and Telegraph Company in Seattle, Washington. He joined the company in June, 1956, after getting his B.S.E.E. degree from Washington State University. "I wanted to work in Washington," he says, "with an established, growing company where I could find a variety of engineering opportunities and could use some imagination in my work."

Dick spent 2½ years in rotational, on-the-job training, doing power and equipment engineering and "learning the business." Since April, 1959, he has worked with microwave radio relay systems in the Washington-Idaho area.

When Dick breaks out his checkered shirt, he's headed for the mountains. He makes field studies involving microwave systems and SAGE radars and trouble-shoots any problem that arises. He also engineers "radar remoting" facilities which provide a vital communications link between radar sites and Air Force Operations.

A current assignment is a new 11,000 mc radio route from central Washington into Canada, utilizing reflectors on mountains and repeaters (amplifiers) in valleys. It's a million-dollar-plus project.

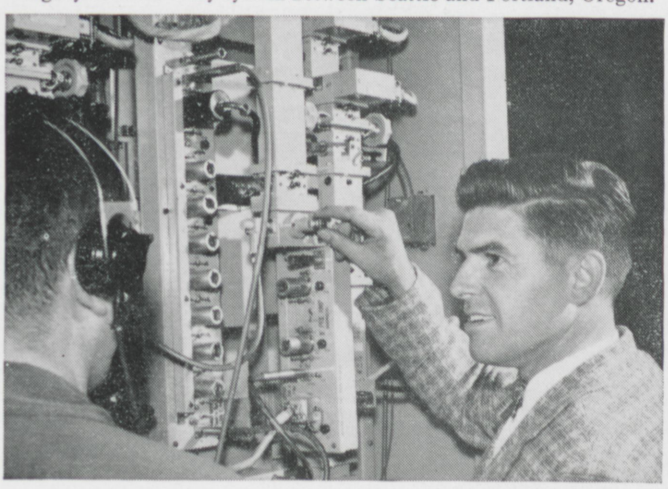
"I don't know where an engineer could find more interesting work," says Dick.

* * *

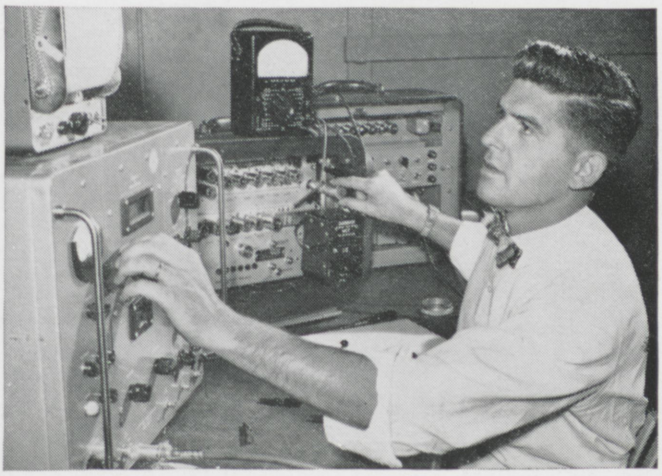
You might also find an interesting, rewarding career with the Bell Telephone Companies. See the Bell interviewer when he visits your campus.

BELL TELEPHONE COMPANIES

Dick stops by the East Central Office building in Seattle to look at some microwave terminating equipment. It's involved in a 4000 megacycle radio relay system between Seattle and Portland, Oregon.



In the Engineering Lab in downtown Seattle, Dick calibrates and aligns transmitting and receiving equipment prior to making a path-loss test of microwave circuits between Orting and Seattle.



(*Continued from page* 13)

3% entrained air and 20% of the cement by weight replaced by fly ash. The resultant 28-day compressive strength was 4500 pounds per square inch.

Lednock Dam and Lubreoch Dam, Scotland. Fly ash concrete is being used in Scotland at the Lednock Dam and the Lubreoch Dam. In Scotland fly ash concrete seems to answer the engineers' wishes, since design there, to retain the aggressive waters, has long been based on impermeability rather than strength. Generally this impermeability was gained by a high proportion of cement, but now fly ash fills the bill.

FLY ASH AS AN AGGREGATE

As an interesting sidelight to this discussion of fly ash in concrete, it might be noted that fly ash has also been used as a substitute for the aggregate in concrete. In this capacity fly ash, with the portland cement, water, and a foaming agent, form a type of lightweight structural concrete called cellular or foam type. Cellular concrete has a large amount of entrained air, usually exceeding 25%. Properly made cellular concrete has satisfactory strength, light weight, and low thermal conductivity. It is easily molded and worked, and it is reasonably durable and noninflammable. Its chief disadvantages are its high setting and drying shrinkage and the size changes resulting from variations in moisture content. Even though quite a bit of experimenting has been done with this type concrete, it is not currently important in the United States.

CONCLUSIONS

Fly ash, the ash collected by precipitators in coal-burning power plants, is coming into common use as a partial replacement for cement in concrete. The primary advantage to the use of fly ash is the economic saving. Since fly ash is itself only a waste product, it is certainly much more economical than the cement it replaces.

Extensive testing has been carried on in regard to using fly ash in concrete. The results of this testing are summarized below. These results are based on 20-45% substitution compared with 100% portland cement.

1. Fly ash raises the tensile strength of concrete.
2. Fly ash lowers the compressive and flexural strength of concrete for periods of up to one year after pouring; after one year the compressive and flexural strengths are as high or higher.
3. Fly ash decreases the shrinkage in concrete.
4. Fly ash decreases the lime leaching.
5. Fly ash makes the concrete more impermeable.
6. Fly ash inhibits the expansion resulting from the alkali-aggregate reactions.
7. Fly ash does not improve resistance to freezing and thawing.
8. Fly ash lowers the resistance to calcium chloride, which is used for ice removal.

Even though the last two results do not favor the use of fly ash in highway work and the second result might also be against its use where early strength is desired, the savings which result from the use of fly ash coupled with the other desirable characteristics certainly favor the use of more and more fly ash in concrete.

The growing list of structures built with fly ash concrete backs up this statement: a few such structures include Liberty Dam, Baltimore; Palisades Dam, Idaho; Hungry Horse Dam, Montana; and Canyon Ferry Dam, Montana.

Fly ash, along with other pozzolans, has a big future in the concrete industry. Fly ash as a partial replacement for cement offers many advantages, the biggest of which is economy. Fly ash will help make today and tomorrow's concrete better and cheaper.

(*Continued on page* 34)

ANALOG COMPUTER

(*Continued from page* 18)

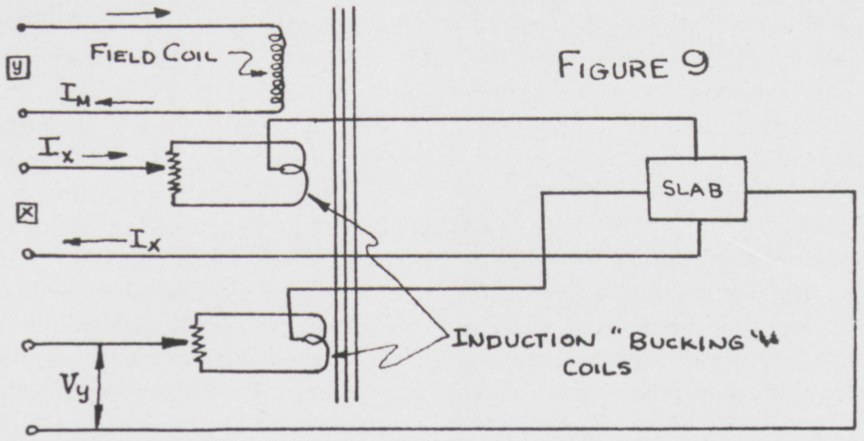


FIGURE 9

I_mI_c oc V or analogogously yK oc y (as above) we have

I_mI_x oc V_y or yx oc z.

The feedback system will continuously correct all errors in the field amplifier and the magnet itself. If the slabs are exactly alike, it will also correct all slab errors. It checks up everything in the system except the x and z amplifiers, and keeps this system working as it should.

Lofgren's unit also uses Ferroxcube core.

SUMMARY

An analog computer consists of a special electrical circuit. The variables of this circuit, voltage and time, will behave like, and hence are analogous to, the variable of a differential equation. Different equations require different circuits. The computer solution of the equation is expressed as a voltage-time graph.

A computer multiplier takes two voltages (or currents) as an input and produce an output voltage (or current) proportional to the product of the input voltages (or currents).

A new type of multiplier uses the Hall Effect in a semiconductor. If a current passes through a semiconductor slab in a magnetic field at right angles to the current, a voltage will be produced across the slab at right angles to both the current and the field. This voltage is proportional to the product of the field and the current. Since the field is proportional to its producing current, the output voltage is proportional to the product of two currents.

Several experimental Hall mutipliers have been built. One of these has speed and accuracy characteristics comparable to the best existing electronic multipliers.

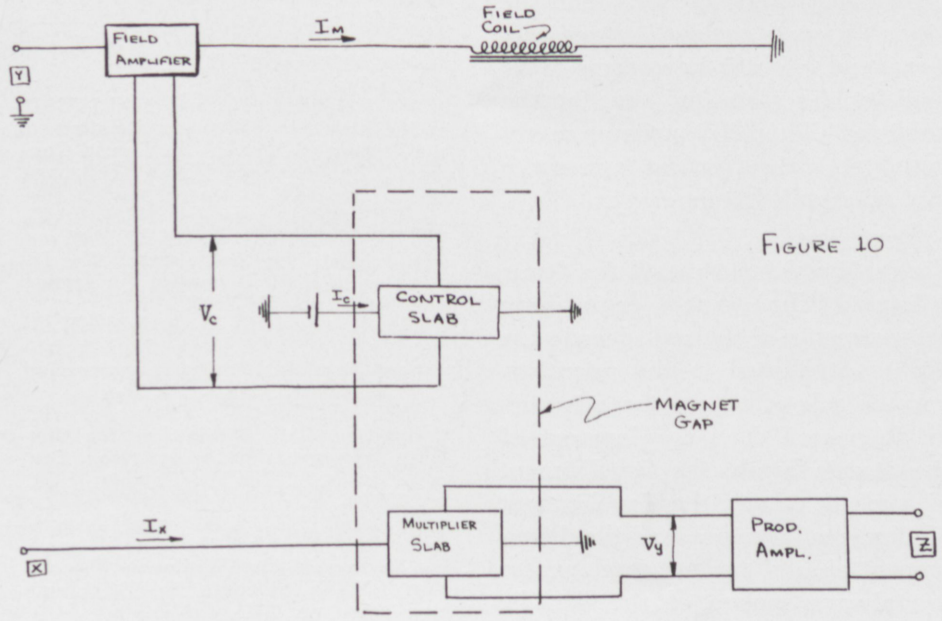


FIGURE 10

LOCKER RUMORS

(*Continued from page* 30)

In basketball, the BII Celtics are still the team to beat. Within striking range are the Junior Jems, the Senior Civils, both at 4-1. The Sophomores and the Deming Demons still have a mathematical chance at 4-2. The next few weeks will be tough on the leaders, for they have yet to meet two of the four teams who are in contention.

In I.F. play, Theta Xi, being undefeated, is still pushing for the championship. With only a few weeks to go, their main worry will be Sigma Nu, which is only a game behind. Following Sigma Nu in the standings are Alpha Tau Omega and Lambda Chi Alpha. Neither of these teams are to be taken lightly, however. Both teams have the potential to upset either of the top two teams.

A playoff between the Juniors and BI for the volley ball championship will highlight this week's activity in intramural volleyball. At the present time both teams are undefeated in league competition. The game should prove to be a real battle, with victory landing the championship.

Intramural bowling has produced some very interesting and tight games. At the present time there is a tie for first place between Jack Gilmour's junior team and George McLellan's sophomore team at 10-2. Following them is Ed Kitchen's freshman five at 10-4. In a three way tie for fourth place are Joe Andel's sophomore group, Dick Pike's junior team, and the senior "giant killers", headed by Tom Feutz. Their records are 8-4. Competition is very keen and the championship could still be won by any one of the six teams.

The ping-pong tables at school will soon be buzzing with activity as the intramural ping-pong championship playoffs swing into action. The list of competitors for the singles championship is headed by defending champion Dick Landenberger. Judging from some of the matches witnessed in the Student Center, the competition should be pretty stiff.

EXPLOSIVE CUTTING

(*Continued from page* 15)

for x greater than O along $y = O$ and along $y = y_o$ for all x; these conditions determine the wave flow.

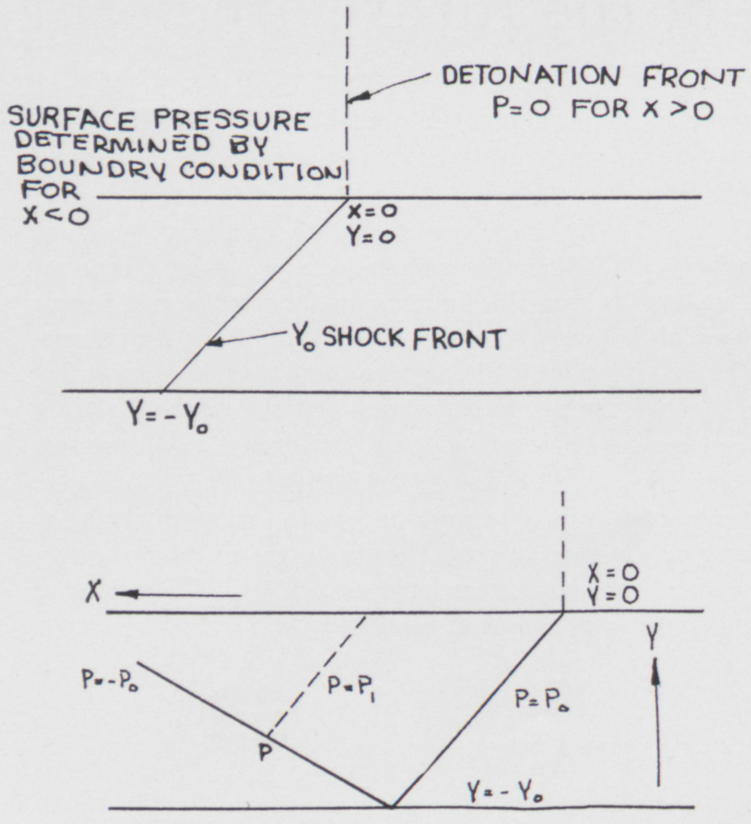
Consider first the boundary condition for $y = -y_o$. The free boundary reflects the shock front as a tension wave front, thus making up the two characteristics $y = ax + b$ and $y = -ax + b$. As shock waves sweep along, following it up is a tension wave starting at the free surface.

The tension front always has a negative pressure equal to the positive pressure of the shock front. So at any point P on the tension front, there is a pressure equal to the negative pressure $-p_o$ and p_1, the pressure at the point on the explosive-metal interface.

As progress is made along the tension front away from the shock form, the tension increases. As long as the tension does not become greater than the breaking strength of the metal, an undesired split called a flat spall along the bottom of the metal.

Now to explain the end split. There is a local tension maximum where the tension wave from the bottom meets the rearification wave front from point A. The metal splits if this tension exceeds the breaking strength. As the metal splits, the pressure goes to zero, thus there must be a point source of negative pressure equal to the magnitude of the positive pressure at the front of the break. This negative pressure then propagates along with along with the sound velocity. The metal breaks along the intersection of the rarefication wave front and the tension front. As can be seen from the pictures, R and T first meet at the center of the metal, then proceeds to the outside.

For the split lengthwise down the metal, the same principle applies. A point split occurs at each point along the length of the explosive sheet and a line split is the final result.



JOKES

A preacher recently announced that there are 735 sins.

He is being besieged with requests for the list, mostly from college students who think they're missing something.

* * *

Mrs. Worthmore and her French poodle were shopping one day, when she noticed the man standing next to her at the counter was looking fearfully at the puppy frisking about his legs.

"My, my," she said, "don't be afraid of Felix, he won't bite you."

"Madam," said the man, "I was not afraid he'd bite, but I noticed him lifting his hind leg and I thought he was going to kick me."

* * *

A Texas oilman was visiting New York. His city friend showed him all the sights, including the Empire State building.

"Isn't that a magnificent structure?" asked his friend.

"Nothin," said the Texan. "I got an outhouse bigger'n that."

The New Yorker looked him over. "You need it," he reported.

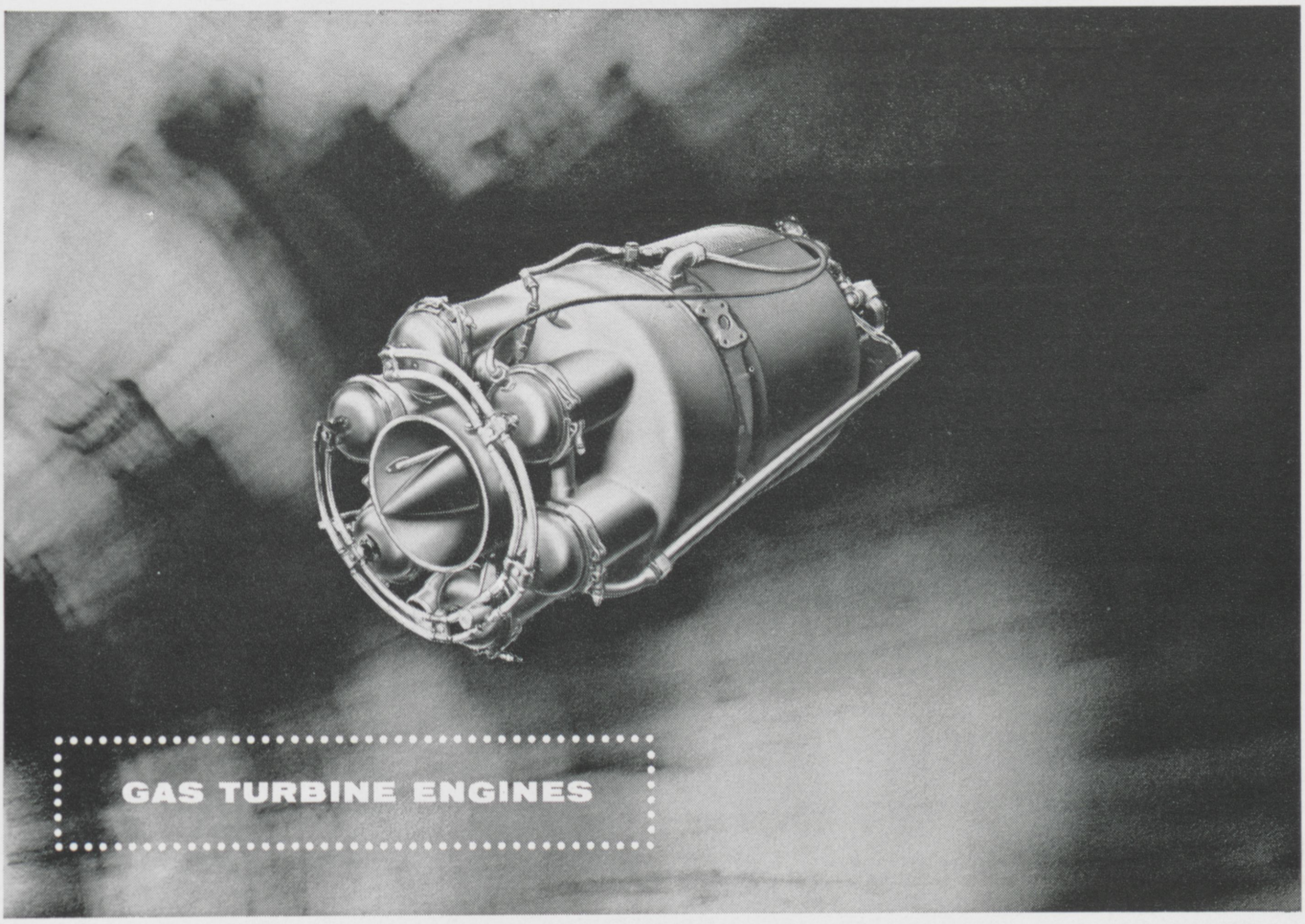
* * *

The little moron's watch had stopped ticking and he tried to find out the trouble. Finally, he took the back off and found a dead bug in it.

"No wonder it doesn't tick," he said, "the engineer is dead."

* * *

"What didja mean uncouth?" the engineer to his sweetheart. "Don't I take you to the opera, the ballet, the flower show, and all that garbage?"



• The small gas turbine is an important aircraft support item used primarily for starting jet engines and providing on-board auxiliary power. The high compressed air and shaft outputs for its small size and weight mark it as an important power source for common commercial use. AiResearch is the largest producer of lightweight gas turbines, ranging from 30 H.P. to the 850 H.P. unit pictured above.

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Diversity and strength in a company offer the engineer a key opportunity, for with broad knowledge and background your chances for responsibility and advancement are greater.

The Garrett Corporation, with its AiResearch Divisions, is rich in experience and reputation. Its diversification, which you will experience through an orientation program lasting over a period of months, allows you the best chance of finding your most profitable area of interest.

Other major fields of interest include:

• **Aircraft Flight and Electronic Systems**—pioneer and major supplier of centralized flight data systems and other electronic controls and instruments.

• **Missile Systems**—has delivered more accessory power units for missiles than any other company. AiResearch is also working with hydraulic and hot gas control systems for missile accessory power.

• **Environmental Control Systems**—pioneer, leading developer and supplier of aircraft and spacecraft air conditioning and pressurization systems.

Should you be interested in a career with The Garrett Corporation, see the magazine "The Garrett Corporation and Career Opportunities" at your College placement office. For further information write to Mr. Gerald D. Bradley...

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Systems, Packages and Components for: AIRCRAFT, MISSILE, NUCLEAR AND INDUSTRIAL APPLICATIONS

(*Continued from page* 28)

Richard Nixon, by Earl Mazo

On election day, 1954, after a particularly bitter off-year campaign, Richard Nixon told his advisor, Murray Chotiner, "I'm through with politics." Earlier, Nixon had agreed with his wife to retire from national affairs at the end of his term in 1956. Also, Harold Stassen had opposed his renomination for Vice-President, and, further back, during the famous "fund" episode, prominent Republicans had agitated for his removal from the ticket, among them men who selected him.

What kind of man has provoked such spectacular resentments and loyalties in both parties—the man who dictated a telegram of resignation to the Republican National Chairman after his "Checkers" speech? The "jugular" orator many Democratic contenders think they can beat in 1960? The junior naval reserve officer who stood up to a five-star general? The father who doesn't read the Washington *Post* at home because his children might see him in Herblock's cartoons?

Starting with Nixon's birth in 1913, Earl Mazo has assembled a fascinating, intimate account, based on over three hundred interviews with Nixon's friends and enemies, on material in the Vice-President's files, and on more than two dozen candid interviews with Nixon himself.

This is a remarkable book in many ways: it presents an inside view of the administration (especially of party politics) and of Nixon's relations with Eisenhower, Lyndon Johnson, Dulles, Christian Herter, John Kennedy, Senator McCarthy, Nelson Rockefeller, and many others; it shows his differences with the President; it is an account of a unique political voyage; it indicates how Nixon would behave in the executive chair; it shows unrevealed aspects of Nixon's personality.

Anyone concerned with American politics in 1960—and beyond—will find this indispensable and absorbing reading.

(*Continued from page* 19)

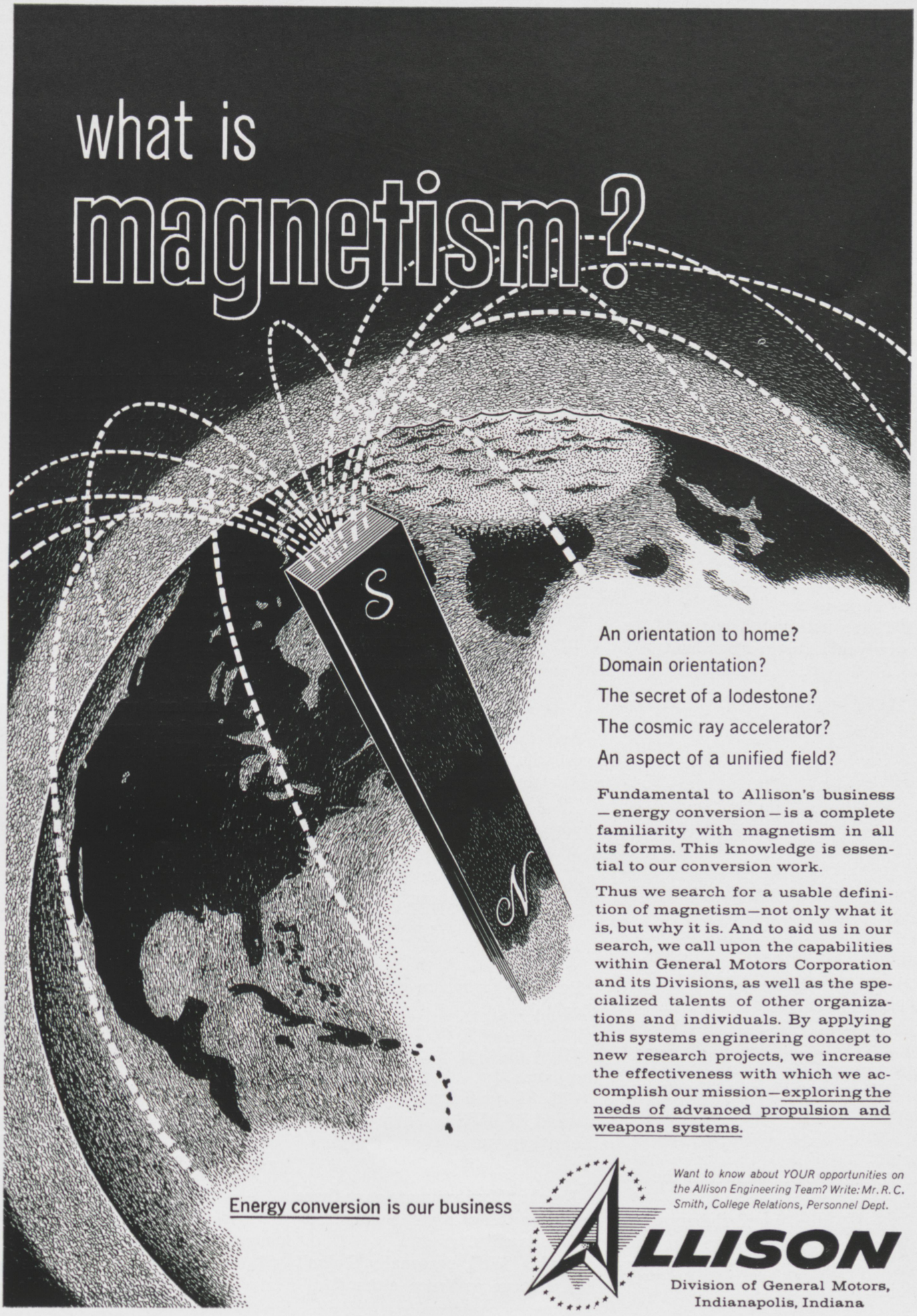
oratory tests of the new oven, the constancy of temperature deviated only plus or minus 0.5 degree F at temperatures of 500°F, 150°F, and 500°F.

The oven has a temperature range of 125 degrees F to 1000 degrees F. The time required for the oven to reach maximum temperature and the maximum electrical input is three and one-half hours and 2500 watts. The use of stainless steel in the oven make the oven one of great durability and a great time saver in cleaning.

The oven has an interior design of great importance with the area measuring 20 inches wide, 19 inches high, and 18 inches deep. The utilization of adjustable shelves is also a feature of great convenience.

The oven is controlled by four switches conveniently placed on the front of the oven. The controls include a temperature controller, a safety thermostat, and master switch, and a cycle controller.

ADVERTISING INDEX



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Domain orientation?

The secret of a lodestone?

The cosmic ray accelerator?

An aspect of a unified field?

Fundamental to Allison's business—energy conversion—is a complete familiarity with magnetism in all its forms. This knowledge is essential to our conversion work.

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Want to know about YOUR opportunities on the Allison Engineering Team? Write: Mr. R. C. Smith, College Relations, Personnel Dept.

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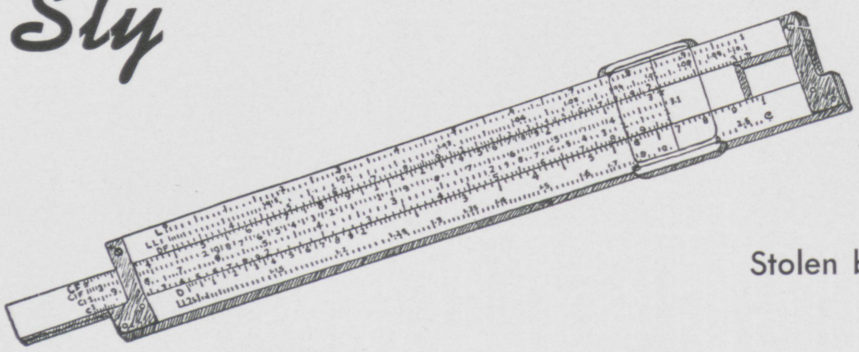
Indianapolis, Indiana

Sly Droolings



Stolen by Bob Franzwa, jr., m.e.

The difference between amnesia and magnesia is that the fellow with amnesia doesn't know where he is going.

* * *

Have you heard about the girl they call turnpike because there isn't a curve in sight?

* * *

"Hey! Did you see that young lady smile at me?"

"That's nothing. The first time I saw you I laughed out loud."

* * *

House mother: "When I was your age, young girl, a nice girl wouldn't think of holding a man's hand."

Coed: "But nowadays a nice girl has to hold a man's hand."

* * *

An elderly man entered a local doctor's office recently and requested a blood test.

"Now what would you be wanting that for?" asked the doctor.

"I'm getting married," was the reply.

"Married," gasped the doctor, "would you mind telling me how old you are?"

"Ninety-four!" was the proud reply.

"And how old is the prospective bride?"

"Twenty-two," answered the old fellow.

The doctor was flabergasted. "Why an age difference like that could easily prove fatal," he exclaimed.

The aged romeo thought this over for a few seconds and then after weighing the pros and cons carefully, made up his mind.

"Well doc," he said, "that's her tough luck, if she dies she dies."

* * *

We point with pride to the purity of the white space between our jokes.

* * *

If young girls stay out late, drink, smoke, and pet, men will call them fast . . . . as fast as they can get to the phone.

* * *

And then there was the freshman who thought a neckerchief was a sorority president.

* * *

Policeman (to an intoxicated man who is trying to fit his key into a lamp post): "I'm afraid there is nobody home."

Mus' be. Mus' be. There's a light upstairs."

* * *

People who live in glass houses shouldn't.

* * *

"How did you find the ladies at the dance?"

"Oh, I just opened the door marked LADIES and shore enough there they were."

* * *

Frosh: "My roommate says there are some things a girl shouldn't do before twenty."

Soph: "Well, personally, I don't like a large audience either."

A quiet little freshman co-ed from the country was on her first college date, and thrilled beyond words. She didn't want to appear "countrified"; she had put on her prettiest dress, got a sophisticated hair-do, and was all prepared to talk understandingly about music, art, or politics.

Her hero took her to a movie and then to the favorite college cafe.

"Two beers," he told the waiter.

She, not to be outdone, murmured, "The same for me."

* * *

"My husband would never chase after another woman," declared the lady. "He's too fine, too decent, too old."

* * *

Hubby sneaked home at 3:00 a.m. His angry wife met him at the door. "So! Home is the best place after all!" she snorted.

"I don't know about that," her mate replied, "But it's the only place open."

* * *

The young lady eyed her escort with disapproval. 'That's the fourth time you've gone back for more punch, Albert," she said coldly. "Doesn't it embarrass you at all?"

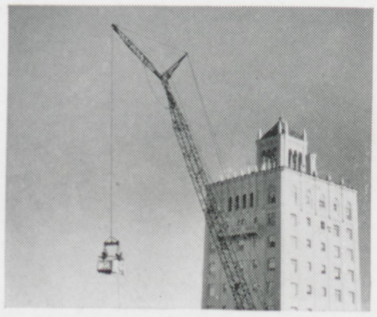
"Why should it?" the young man shrugged. "I keep telling them I'm getting it for you."

* * *

Notice in want ads—Young man man transferring from Rose to State would like to trade one good study lamp for a comfortable bed.

Though the building is not yet built, this is a view from one of the apartments.

How to look out a window before the building is up



With 180 "view" apartments to sell, the developers of The Comstock turned to photography to get a jump on sales

A feature of The Comstock, San Francisco's new co-operative apartments on top of Nob Hill, will be the spectacular panoramic views of the Bay area from their picture windows.

How could these views be spread before prospective buyers—before the building was up? The developers, Albert-Lovett Co., found the answer in photography. From a gondola suspended from a crane, color photos were made from the positions of the future apartments. Now, the sales representative not only points out the location of a possible apartment on a scale model, but shows you the view from your window as well.

Photography rates high as a master salesman. It rates high in other business and industry tasks, too. The research laboratory, the production line, the quality control department and the office all get work done better and faster with photography on the job.

Whatever your field, you will find photography can save you time and cut costs, too.

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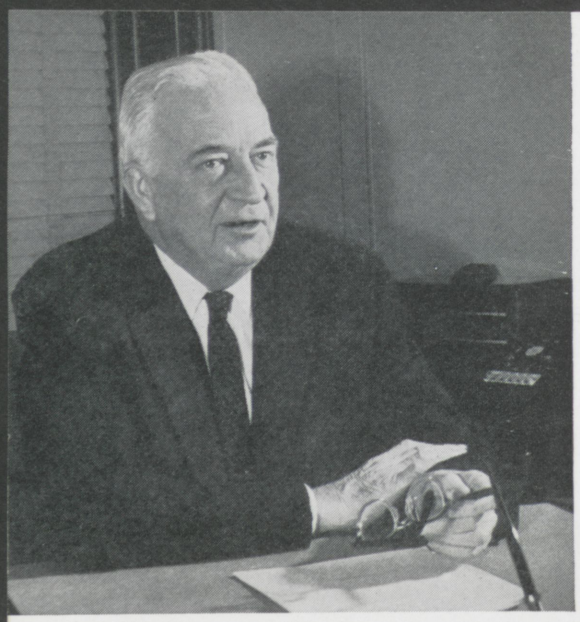
Kodak
TRADE MARK



One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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